The CO_2 Connection: A Hidden Clue to Air Quality with Dr. Allison Bailes

SPEAKERS
Dr. Allison Bailes, Kendra Seymour

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Dr. Allison Bailes
00:00
They have, they list several things about carbon dioxide. It can be a good indicator of how much air exchange you're getting with outdoors. It's not something that you look at a number and says, Oh, your, your carbon dioxide is 1500 parts per million, your, your indoor air quality is really bad, right now, you don't know that. All you know is your carbon dioxide level is high. You're not getting enough air to bring that carbon dioxide level down, which means you're also not diluting other pollutants in the air.

KS
Kendra Seymour
00:35
Hello everyone, and welcome to Your Indoor Air podcast brought to you by Change the Air Foundation. My name is Kendra Seymour, and I'm so glad you're here today. We're going to be having a fascinating conversation with Dr Allison Bailes. And he is the author of the best selling book on residential building science, A House Needs to Breath or Does It?, and the founder of Energy Vanguard, a building science firm and BPI Test Center located in Decatur, Georgia. The company's focus is on residential HVAC design, consulting, and training. Dr. Bailes has a PhD in physics from the University of Florida, and has been involved with the field of building science since 2001 when he built a high performance home out of Structural Insulated Panels. So today we're going to be diving into questions like, Where does CO2 come from in our homes, and what might it be telling us about our home? And we'll talk about kind of the thesis of his book, A House Needs to Breath or Does It?, plus, we'll explore a layered approach to ensuring our homes have the fresh air that they need. So thank you, Dr Bailes, so much for being here.

AB
Dr. Allison Bailes

01:32
Oh, you're welcome. I'm happy to be here, Kendra.

KS
Kendra Seymour
01:34
So before I jump in, I do need to take a moment to say thank you to two of our sponsors. Now, we truly appreciate our corporate partners, not only because their businesses are committed to changing the way we address mold and water damage and pour indoor air quality in our homes across the country, it's their support that helps keep our resources free and available to the public. So a huge thanks to Celtic IAQ and Mold Mentor LLC. And if you want to find out more about our corporate partners, you can head on over to our website, ChangetheAirFoundation.org, and click on our corporate partners tab. So Dr Bailes, I was so excited when your book came out before it was one of those things I told my family like I wanted it as a birthday present because I couldn't wait to dig in. I think you saw my copy just now. I have post it notes and notes all over and so I can't wait to dive in. But let's start with just kind of grounding some people to some basics, because you also have a fantastic blog, and one of the things I've seen you talk about is carbon dioxide, and I've heard you say that it's kind of like a check engine light. So let's start first with, well, where does it come from in our homes, and what does and doesn't it tell us about the air inside, you know, our buildings?

AB
Dr. Allison Bailes
02:47
Well, that's a great question. And there's a lot of misunderstanding around the topic of carbon dioxide, because I don't have mine in front of me here, it's in the bedroom, but I've got a little carbon dioxide monitor, measure temperature, relative humidity and carbon dioxide, the air net four. Everybody's got one. It seems like, well, everybody in my sphere has one. Yeah, I've taken it on lots of trips with me. Measured the carbon dioxide levels on airplanes and in hotels and all kinds in cars. The biggest source of carbon dioxide in most houses is going to be just people breathing, because when we inhale, we're bringing in oxygen, and that we have this gas exchange happening in our lungs. The oxygen goes into our bloodstream and waste products come out, and one of those waste products is carbon dioxide. So if you put somebody in a closed room with no air exchange with outside, and they just sit there breathing. The carbon dioxide level in that room will go up. And you know, like you put your head in a paper bag, it's going to go up even faster, because you got less volume of air, you're going to get really high spikes in carbon dioxide. The smaller the volume is, and the more people you have. Another source of carbon dioxide, though, is combustion. If you're doing any kind of combustion in the house and not venting it directly to the outdoors, that can be putting carbon dioxide into your home. Ventless gas fireplaces, for example, or unvented space heaters, gas stoves, gas ovens. You know, if that stuff, if the range hood is not on when you, when you're cooking with with gas, you're also getting carbon dioxide in house, but a bunch

of other pollutants as well from that. So the the reason I said it's like a check engine light is carbon dioxide is, is not a pollutant directly, certainly not at the levels that we're breathing, even, even if it gets up to 1000, 1500, 2000, the research on that is inconclusive. ASHRAE, the the trade association for professionals in any, um, air conditioning, heating, refrigeration, engineering. They have a position document, and they, you know, they have, they list several things about carbon dioxide. It can be a good indicator of how much air exchange you're getting with outdoors. It's not something that you look at a number and says, Oh, your your carbon dioxide is 1500 parts per million. Your your indoor air quality is really bad, right now, you don't know that. All you know is your carbon dioxide level is high, which means, based on the production of carbon dioxide in that space and ventilation or infiltration, you know, exchange of air between indoors and outdoors, you're not getting enough air to bring that carbon dioxide level down, which means you're also not diluting other pollutants in the air. So volatile organic compounds, you know, gasses that are floating around the air, ozone and carbon monoxide, if you have that the all these pollutants are in the air. And when we ventilate, we bring outdoor air in. Outdoor air these days has a carbon dioxide level of over 400 parts per million most of the time. And when you're going, if you're at 1000 parts per million indoors, you bring in some 400 parts per million air in from outside, and your indoor level will drop depending on how quickly you ventilate. So it's a good indicator, indicator of how much air exchange you're getting. It's not a good indicator of indoor air quality.

KS

Kendra Seymour

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No. I mean, you've written about this before, where you've actually gone to, like big conferences, and you have your CO2 monitor, and you track that and, and I love that analogy. It's like a check engine light, because it's all those things you mentioned, the VOCs and carbon monoxide, if that's an issue. But even viruses, and you think of things like coming out of COVID and things like that, that the ventilation matters, right? The amount of fresh air that we're breathing in, and CO2 seems to be a little easier to measure than some of those other things we know, whether it's, you know, mold spores or VOC some of those things are more challenging to to assess, especially in real time. And so something like that can be a nice clue, I think, to hey, maybe there's something going on. So is, I'm curious, in your opinion, is, is CO2 something like the average person should be monitoring, should or is it just more something to be aware of, something that IAQ or IEQ professionals use?

AB

Dr. Allison Bailes

07:33

Well, we have some really good, relatively inexpensive indoor air quality monitors now that measure CO2 and other things like I've got, I've got four different indoor air quality monitors in my house that measure a range of different things. They measure temperature and relative humidity. All of them measure that. All the ones I have also measured carbon dioxide. They measure particulate matter. They measure what some

of them call chemicals, volatile organic compounds. One, one of mine also measures radon in the house and atmospheric pressure, and so there's some good indoor air quality monitor you can get that will give you a much better snapshot of your indoor air quality than just looking at CO2. CO2 is good, you know, a little bit. It'll tell you something, you know, something about the air exchange. But going back to that, you know, I said that it's not a good indicator of what your indoor air quality is, because, number one, the ventilation, the air exchange you have with outside, either through ventilation or infiltration, two different things, the will dilute the carbon dioxide and other gasses in the air, and also particles. So there's, there's two kinds of pollutants floating around in your air. You've got the gasses, things that are single molecules, like nitrogen, oxygen. Those are gasses. Those are things we want in the air. That's most of what the air is, but then we've got particulate matter. This could be all kinds of stuff, and the outdoor air is responsible for a lot of the particulate matter that we have indoors, if we especially if we don't have an airtight house. So that's why air tightness is a really good thing for indoor air quality. We keep the outdoor, the bad stuff outdoors from getting inside, but we still do plenty of bad things inside make the air bad, But going back to the particles versus gas thing, particles are easy to get rid of. That's what filtration is for you. If you have a really high efficient, high efficiency filter, like MERV 13, is where most IAQ researchers say you want to be. There's MERV is a scale for the efficiency of filtration, and it goes from one to 16. That's an ASHRAE based on an ASHRAE Standard. Merv 13 is not the highest efficiency you can get, but it's a good compromise between really high efficiency. And relatively low pressure drop, you know, resistance to air flow, because the more efficient the filter you put in, the more resistance to air flow. And so you might mess up the air flow in your heating and cooling system if you put a filter in that's too resistive.

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Kendra Seymour

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yeah. I'm glad you brought that up. Because sometimes, first of all, if you're listening to this and you're not aware, you should be regularly changing your filter in your HVAC system, having that system maintained. And sometimes people will think, Well, higher is better. And they'll be like, I'm just going to try to stick the highest filter I can. And you want to make sure that you are sticking with what that your unit is appropriate for your unit, because you can then have that unattended consequence, and so always check with a knowledgeable HVAC technician on that. Wanna just give that little plug there as a reminder?

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Dr. Allison Bailes

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Yeah, absolutely true. And I've written a lot about filtration and how to do high MERV filtration, MERV 13 filtration with low resistance to the airflow, and that is, you just have to make the filter bigger to make that work. I've got MERV 13 filtration in my house, very low resistance, and I don't need to change my filters more than about twice a year. Every six months I change them, and even after six months, there's a lot of

dirt on them, but because they're so big, there's still the air is still able to move through without much problem.

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Kendra Seymour

11:28

Yeah, so before we jump into ventilation, which is where we're kind of going to segue into and a little bit more about the topic fully of your book. But the reason why we brought up CO2 is I do like that as an easy entry point for people to start thinking about this, because I know, like, once you know, you exhale, CO2, and you know, when you're in a tight space, or whatever, I know, I start thinking about, like, What is everyone else exhaling? Is anyone sick? I really don't want to get sick, and so the solution there kind of pivots to ventilation. But we had talked about just the CO2 on its own, not necessarily being an issue. But I know you had written before about there was a Harvard study, I believe, on CO2 and VOCs that I thought was interesting. And can you speak to that a little bit, and what it what it claimed to find?

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Dr. Allison Bailes

12:18

Yeah, I don't remember all the details, but they, they looked they so they had an office environment dedicated for research, and they, they put some people in there, and they exposed them to different levels of of carbon dioxide and some other pollutants, and they looked at their they gave them cognitive tests, and looked at how well they did with different levels of these pollutants. And it's been a decade since I looked at that, but as I recall the you know, the they did find correlation between the the carbon dioxide level and people's cognitive abilities, although, you know the ASHRAE position document, they they've looked at a wide range of research, and that's that's one study that shows that, yes, carbon dioxide levels, you know, even like 1000, 2000 parts per million can affect you, but there's plenty of other studies showing that even higher levels may not affect you very much. I mean, you know people on submarines and and space stations and things deal with high, pretty high levels of carbon dioxide. And so the military and NASA certainly looked at that issue in great detail.

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Kendra Seymour

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Well, that's the top ventilation then, because I feel like that is a positive overall. So for those listening like, what is it exactly, and why is it important? And then we'll kind of talk about what we can do with that.

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Dr. Allison Bailes

13:45

Okay, before we we really get into ventilation, let me talk a little bit more about filtration, because so there's particles and gasses in the air. Filtration, with high efficiency filters can remove the particles. Those particles can be the PM2.5, particulate matter 2.5 microns or smaller. That's the really bad kind of particles, because you breathe them in, and they can get all the way into your lungs and into your bloodstream and

into your heart and into your brain and cause all kinds of health problems. And the filtration can remove that stuff also, I mean, during COVID, you know, a lot of the the WHO was reluctant at first to admit that COVID was airborne, but finally, they did admit, you know, the research made it clear that it's not from surfaces. We don't need to disinfect all the groceries we bring into the house and everything. It's from the air. These aerosolized viral particles were floating around for hours or days, and somebody else breathes them in at a high, you know, high enough concentration and they get sick. So filtration can take that kind of stuff out. The standard media filtration does not remove gasses. You know, the nitrogen oxides and carbon monoxide and carbon dioxide and radon. So those things go right through the regular filters. They're just single molecules. They're too small to get caught by the filter. That's what ventilation is for. Well, actually, even before ventilation, let's back up, because there is source control. I just wrote an article last week, published last week, called Seven Steps for Good Indoor Air Quality, I think, or something like that. And in there, your source control is number one, don't bring bad stuff into your house when you know, as much as you can control the stuff that you put into your indoor air by what you bring into the house and what you do in the house. So when you know, don't weld in the living room, for example.

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Kendra Seymour

15:40

Pay attention to your building materials, right? Like, what paint you're using, glues and adhesives in your your building chairs. We're doing a whole lot of conversation around just that, the VOCs this year, because it's so important, and not something people think about, because it does start with source control. I completely agree.

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Dr. Allison Bailes

15:58

Yeah, source control is always number one. And then there's one other one that I already mentioned, and that's air tightness. Because, you know, there's bad some of the pollutants come from outdoors. We don't want them to come in. You know, especially if you have an attached garage or a moldy crawl space down below, a dirty attic up above, you don't want that air from those spaces getting into the house. So air tightness, so source control, air tightness, filtration, ventilation. That's four of the seven. And then there's moisture control and pressure balancing and indoor air quality monitoring. I talked about the the monitors that we can get now, if when you when you do these other six things, you know, a couple $100 on an indoor air quality monitor can tell you if they're having the the effect that you want. You can see what your particulate level is in the house. And, you know, mine stays pretty low, almost always. Our VOC, our chemical level is usually pretty low. You know, we have daily spikes, though, when cooking, and even, even, even with the range hood on, we still get those spikes.

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Kendra Seymour

17:04
Yeah, I have a monitor as well, and it's funny. I can tell when one of them is, like, near our kitchen. It's like, open concept. And I can tell when we're all sitting around the table for dinner eating, because I can see, because it mind tracks, like CO2 and PM 2.5, all that stuff. And I can see like, spikes, or when I'm cooking, too. It doesn't last long, thankfully, but it's really interesting to kind of see that, especially over time, historical data. Do you have a system that you you like in your home that some of our more ambitious homeowners and runners might want to look into?

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Dr. Allison Bailes
17:35
Yeah, the two, the two different brands that I have, I have the Awair element, and that's A W, A, I, R, and the I have two of those. And then I've got two different types of monitors, from Airthings. And the one of the Airthings monitors is the one that monitors radon for me, because, you know, we're in a high radon area, and we do have elevated radon in our house. I've got it down some, but I've got more work to do there.

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Kendra Seymour
18:06
Yeah, and we actually, for those listening, if you're interested about radon and you mentioned carbon monoxide, we have two really interesting podcast episodes we did. I'll link to those in the show notes. And I'm going to link to your article, Allison, because I read that last week and that was a great one, so that people can find it, because it really is, and we're going to get into this too, this, like, multi pronged approach to addressing the air inside your home, so then for ventilation, because I feel like that's something people don't really understand. Like, how does that work? Is that just through our HVAC system? Is it through makeup, air or an ERV? When you say ventilation, what do you mean? Exactly?

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Dr. Allison Bailes
18:38
Yeah, that's a great question. First of all, let's, let's define it clearly so there's different kinds of ventilation. And also, people use the word ventilation to mean something that typically isn't usually meant for ventilation. Well, I guess it is. Ventilation is, you know, has to do with moving air. So some people talk about just, if you have a forced air heating and cooling system, the air moving through the ducts, they think of as ventilation. But that's, that's a closed system. Ideally, you're just moving air, you know, from the house into the system and then back into the house. So that's a, you know, you're just, it's a closed system inside the house. So you're, you're not exchanging air, any indoor air, with outdoor air. Well, ideally, but Duct Leakage means that often those things do. So the um, you know that's that's not the kind of ventilation that we're talking about when we say ventilation. The kinds of ventilation you know that we're

talking about, well, so there's, there's different kinds of buffer, space, ventilation. So crawl spaces, you know, the building codes say, if you have a crawl space, a vented crawl space, you need to have vents, you know, certain amount of vent area for the size of the crawl space. Same thing with attics. You've got to have a certain amount of, of area to vent, a vented attic, ideally with soffit vents and ridge vents. And then you have, you know, radon venting. So there's sub slab depressurization, which vents gasses from under the slab or under a crawl space vapor barrier out to above the house somewhere, and you can do garage ventilation. So you could put an exhaust fan in the garage, so every time a door opens to the garage, the fan comes on to prevent stuff from getting into the house. And then there's local ventilation. This is something that pretty much every house has, not every house. There are some older houses that don't have any but local ventilation would be your bath fans, exhausting air from the bathrooms and range hood, exhausting air from the kitchen. That's local ventilation. And then what , I because of the work that I do and everything, most of the time I try to specify when I'm using it this way, but a lot of times when I'm talking about ventilation, it's whole house ventilation. So this is aside from all the buffer space ventilation that we talked about, aside from the local ventilation, you can do whole house ventilation, and there's a bunch of different ways to do that. There's three basic strategies. One is exhaust only. So you use the fans you already have your bath fans and your range, right? You put some controls on them so they run continuously at a lower rate, ideally. You can do them intermittently, but have them run more than if you just turned them on for a shower or cooking, and so exhaust only puts the house under negative pressure, so it's just sucking in air through the random leaks in the building enclosure, which is not so great, especially if you have an attached garage or a moldy crawl space or a dirty attic that you're sucking that air through. And the next one would be supply only ventilation, whole house ventilation. This is where you're blowing air into the house, but you're not removing any directly. You can do this by just having a fan blowing air into the house. That's not the best way to do it, because then you're just bringing straight, unconditioned, maybe unfiltered air into the house. And that's not ideal. One other way to do it would be with something called the central fan integrated supply. This is where you have so if you got a forced air heating and cooling system on the return side, so the return side is where it's pulling, the blower in the unit is pulling air back to be conditioned again and then send it back to the house. So on the return side, the duct work is under negative pressure. If you take that return side and you run a duck from it to the outdoors, when the system is running, it will pull air in from outdoors through that duct. So you size the duct properly, and you put dampers on it so that you can control when, when you're bringing outdoor air in or not, and that's air from the outdoors and goes through the system, it gets conditioned, it gets filtered. So that's a better way to do it than just blowing air straight into the house from with a fan. Another way to do supply only ventilation, in humid climates we specified this a lot in our HVAC design work. As with a ventilating dehumidifier, you can with a dehumidifier, you can have ducts on it. There your whole house dehumidifiers that you have on the intake side, you have a duct to an intake grill somewhere in the house. You can also bring in another duct on that side from outdoors. And when the when the dehumidifier is running, or or even if the the dehumidifier is not running to dehumidify, if it can run with the blower on, so that it's just pulling outdoor air in and putting that in the house. So it's adding air to the house without pulling any out directly. And so you that's a supply only system, which means you may end up with a little

bit of positive pressure, which is not a bad thing in most climates and cold climates, positive pressure can create some problems. But what I've read is that the whole house supply only systems generally don't put enough positive pressure in the house to make much of a difference there.

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Kendra Seymour
24:32
Yeah

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Dr. Allison Bailes
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So we got, oh, go ahead.

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Kendra Seymour
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No, please. Yeah, you're doing great.

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Dr. Allison Bailes
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So exhaust only is one strategy. Supply only is another. So exhaust only, we're just second air out of the house. Supply only, we're blowing air into the house. So the third one, of course, is you combine those two into a balanced system. So that's where you're you're pulling air out of the house, and you're blowing air into the house at equal rates. And um, so this is called a balance system. You're balancing the two airflow so you're ideally not changing the pressures in the house. If you get the you know, the two airflow streams balanced properly. And you can do that with two fans blow area on one side and out the other. Or you can do it with something called an energy or heat recovery ventilator, so then you're doing balanced ventilation with recovery, with heat recovery and heat recovery ventilator, or with heat and moisture recovery in an energy recovery ventilator. So HRV is heat recovery, energy recovery, ERV is heat and moisture. So

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Kendra Seymour
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Yeah, and this is one of those things, if people are listening, I know if you're listening and you're considering ventilation, you're probably a little further along in your journey, and you want to be working with a very knowledgeable specialist. And I'm going to even suggest beyond just like the HVAC technician, like you want someone who's going to understand your home as a system. And so maybe we can pivot for just a second then. So before somebody even jumps into this, they need to understand a little bit more

about, like, what are their current ventilation rates. So is there a way that people can measure this? Is this where something like a blower door test can help, like, help us understand, you know, if we're just starting to think about ventilation in our homes, and we want to know what's currently going on, how would somebody go about that?

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Dr. Allison Bailes

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Yeah, so, well, let's, let's distinguish between ventilation and infiltration, because a blower door test is going to tell you about infiltration in the house. Yes. And the infiltration means you've got, you've got some some holes, some cracks in the building enclosure. And when there's a pressure difference between inside and outside, air can move through those holes in the building enclosure. And if the pressure inside the house is lower than pressure outside, outdoor air is going to move into the house. And if the pressure across a hole is the other way, if the indoor pressure is higher than outdoor pressure, air is moving out. And the big drivers for pressure differences are stack effect, wind and mechanical systems. Stack effect is warm, air rises, and that creates a vertical pressure differences. So at the top of the house, you end up with positive pressure because warm air rises in the house, you end up with positive pressure at the top of the house. So if you've got holes at the top, that air is leaking out. And here's a great example of of when you can feel that on a cold winter day, go into the attic if you have a scuttle hole or pull down stairs, go into the attic and then put your your face over the hole, and you will feel that whoosh of warm air rising into the attic. That's the stack effect. Warm air, because of lower density, rises, and if you give it a hole, you know, like an open scuttle hole to the attic or attic stairs, a whole lot of air is going to move through there. At the bottom of the house, the pressure differences are the opposite. The bottom of the house stack effect, top is positive, the bottom is negative. So that's where the air leaks in to replace the air that's leaking out the top.

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Kendra Seymour

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Yeah. And I was going to say in stack effect, like, that's something we'll talk about a little bit more, along with infiltration and some other episodes. But I think people think that, well, what's in my attic or what's in my crawl space cannot impact my indoor living space, and that is not necessarily, there's a lot of factors that go on there. So I know there's been, I've talked with other IEPs and stuff and cases about, you know, townhouses with moldy, you know, crawl spaces, and the HOA is like, Oh, the mold and the crawl space can't infiltrate, and they're able to use, like, theatrical smoke, and they illustrated through the floors and all the leaking pots and up through to the master bedroom. And it was insane. So that's why the home is a system. So I'm sorry, I didn't mean to pull you off track there. But

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Dr. Allison Bailes

29:03
No, that's fine. So yeah, so infiltration is driven by the pressure differences and pathways. For air to move, you've got to have a pressure difference and you have to have a pathway. So stack effect is one of the drivers of pressure difference. It creates a positive pressure at the top and a negative pressure at the bottom in the wintertime was it's and stack effect is a bigger deal in wintertime than in summer, because it's, it's, it's stronger with bigger temperature differences. And in the wintertime you have bigger temperature differences. Because, I mean, here in Atlanta, Georgia, where I live, our winter design temperature is 23 Fahrenheit. If we're keeping the house at 70 in the wintertime, that is 47 degree temperature difference. In the summertime, if we're keeping the house at 75 our outdoor design temperature is 93 so that's an 18 degree temperature difference, and that's a much smaller temperature difference in the summer than in winter. It can still create some stack effect. But in summertime, the interesting thing there is that it's the reverse. The cool air falls and the warm air follows it and the so the bottom of the house has the positive the positive pressure. The top of the house has a negative pressure. So if you open that scuttle hole in summer, you might feel the warm air falling down on you from the attic, from the hot air,

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Kendra Seymour
30:29
Yeah. Or, if you have recessed lights in your, like, top floor and your attic above it, and they're not sealed, well, oh yeah, you can with like, a theatrical smoke or, Oh, hopefully not. The case, you can get moisture start to see mold form around the edges, and it's a sign of, yeah, that infiltration. So

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Dr. Allison Bailes
30:45
Yep, so infiltration does exchange indoor air with outdoor air. It's not the best way to do it, because, because it's coming in from places like attics and crawl spaces and garages, and even when it's coming from outdoors, it, you know, some of it gets filtered, you know, as it moves through the wall and goes through the fiberglass insulation in the walls. And if you've ever done any demolition on a house and seen fiberglass insulation that's very dirty, well, that's because it's acting as a filter for infiltration. It doesn't mean fiberglass can't work. There are a lot of people who say, Oh, I don't want fiberglass. That's filter glass. It doesn't insulate because look at it, well, the problem is it's not meant to be used in a leaky enclosure. I mean, a cavity. If you put it in a wall, that wall needs to be sealed up. You can't have air moving through it, or you will diminish the effectiveness of the insulation anyway, the

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Kendra Seymour
31:44
Okay, so then how do I know if I have poor ventilation rates, like, oh, the ventilation in my home is not good. Is there, like, a test or something that we can have someone run? And then we want to know that so

that, if we do an intervention, we we can post test, I guess, and know that, hey, this is better. We've improved this. So is there a straightforward way, or

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Dr. Allison Bailes

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the best way to determine how well ventilated or well how much air exchange you have? I'm not gonna say ventilation, because right now, we're not talking about people with a whole house ventilation system. They just, you know, they're having air exchange from the occasional use of local ventilation and from the infiltration that happens naturally because of the holes and the enclosure and stack effect and wind and mechanical systems. So the best way to determine how much air exchange you're happening is with a carbon dioxide monitor Yeah, if you are in, you know, sitting in the living room with the family, watching TV and and the carbon dioxide in the living room goes up to 1500, 1000, 2000 whatever it is, you know, that's pretty high. If it's 1000 or higher, you're, you're not getting much air exchange. You're not getting enough air exchange. And if you go and if you have your carbon dioxide mantra in the bedroom at night, and you go into the bedroom, you close the doors, and you go up to 2500 and you know, I've been in places where that happens, you're not getting the air exchange you need in there. You get getting a very high CO2 level in there, which means you need some ventilation. In my house it's a 1961 ranch house, and until December, we had, we did not have a whole house ventilation system operating here, but I have a whole house ventilation system, an ERV, an energy recovery ventilator now, and we have supplies into all the bedrooms and some of the public spaces. We've got exhaust from the bathrooms and in the kitchen. And so it constantly runs and puts fresh air in the house and exhaust air, stale air from the house. And since we put that in, it depends on what rate I run it at. I've been playing around with the rates, but when I run it, you know, decent rate. We can go in our bedroom at night and close the bedroom door and, you know, it might get up to 700 parts per million, which is really good. The you know, if you got two people sleeping in a bedroom at night and doesn't go above 700 that's, pretty good.

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Kendra Seymour

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Yeah, yeah. And I bet if someone were to walk into your house, they'd notice, like, no odor, because, like, none of those gasses and materials and you guys cooking, none of that is building up in your home for very long, right? Because

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Dr. Allison Bailes

34:35

Yeah, yeah, not for very long. It depends on, on, you know, how recently we've cooked, if you walk into the kitchen, you might smell something if we you know, we've just cooked in there, or something, yeah, especially, especially bacon. I don't need bacon my wife, does. My wife and stepson do.

KS

Kendra Seymour

34:50

My kids can always tell when we're making bacon. It's like their favorite thing, and that odor carries. So so people can talk with a specialist on maybe what makes the most sense for their ventilation? Because there are, like, other considerations like you mentioned. But is there, is there such a thing as over ventilating? Do we have to worry about then, wow, I live in a humid climate. I don't want to be bringing in too much humid air. Is Is there over ventilation concerns ever?

AB

Dr. Allison Bailes

35:16

Absolutely yes, it is possible to over ventilate. And I'll give you an example. So, gosh, almost a quarter of a century ago, ago. Now, I built a house, and it was very airtight house, and we had a whole house ventilation system, but I didn't know what I was doing back then. In 2001, , I, I didn't know nearly as much as I know now in 2025, and I had them put in an HRV, a heat recovery ventilator. The difference between an HRV and an ERV is that moisture exchange and an ERV, the dry air stream, gives up moisture to the or, sorry, the wet air stream, the humid air stream, gives up moisture to the dry air stream. In wintertime, outdoor air is cold and cold air is dry air. There's not much moisture in cold air because it will condense out, you know. So if you're using an HRV, that cold air coming in is dry air, you if you bring in 32 degree air, even if you know, let's say you got, let's say it's 32 degrees, it's, it's freezing cold outside and raining, 100% relative humidity. Let's, let's say so you bring in 32 degree air, 100% relative humidity, and you heat it up to 70 degrees the humidity, the relative humidity of that air, goes down to 20% that just that air. Now it's going to mix with the other air, but you keep doing that, and the the relative humidity of all the air in the house is going to drop. And so we had this HRV, and we were running at a higher rate than we needed. And so then it was running continuously, and we ended up dropping the the relative humidity below 15%. 15% was the lowest my hygrometer could grow, and it would bottom out at 15% and you know, the we had hardwood floors, the cracks would open up between the boards we had tongue and groove on the ceiling, and that was popping and cracking, and kept being afraid that It was going to start falling, but it didn't fall. And so I started changing the ventilation rate, and I used a standalone humidifier in the in the cold weather. And that's a Georgia, I mean, you know, Canada or Minnesota, or, you know, colder place, it's going to be even worse. With an HRV, you are going to really dry out the indoor air. So that's not so it's two things. One, you the question was about over ventilating. So this is one thing that can happen with over

ventilating, with a with a system that doesn't exchange moisture, you can end up drying out the air too much in wintertime. In summertime, you can overwhelm the house with humidity in a humid climate, which is, you know, in the US, that's, that's, most of the population is east of the 100th parallel, which is, you know, dividing lines, sort of between the humid eastern part and the dry western part. So, yeah, over ventilating also, you have to pay attention to outdoor conditions. If the outdoor pollution level is really bad, not even talking about wildfires here, but you have days where ozone levels are high and days where PM 2.5 is high if you're ventilating on those days, even if you have a good filter those it's not going to catch the ozone, unless you have an activated charcoal filter, but the ozone is going to come through. And that, you know, you may be making the air worse by ventilating.

KS

Kendra Seymour

38:56

Yeah. So the balance, it sounds like, like, you know, you never just want to do something like, oh, this will solve my problem without understanding all the components that are unique to your house and your situation, because it matters. And so that's why, again, finding like a smart individual reading your book is very informative. You have lots of of the building science there for people to dig into. So I know we're getting a little low on time, but I want to talk about something that gets thrown around. Since we're talking about ventilation, there's a saying that has been around for a very long time. It's called build right, Or, sorry, build tight, ventilate right? So in your opinion, how accurate is that, and, and what does it mean when you talk about a layered approach?

AB

Dr. Allison Bailes

39:37

Yeah, so that's a great question, the build tight, ventilate right? Those are two, two really good things to do for good indoor air quality. And the the problem with that statement is it makes you think, oh, that's all you have to do. You just, you know, make an airtight house and you put ventilation in, you're, you can have good indoor air quality, but no, really. You need to start with source control, as we talked about earlier. You need to do good filtration and moisture control absolutely, because you don't want mold growing, putting all the spor, spores in the air and creating problems. And you need to do pressure balancing and the monitoring. So all all those things, really, if you, if you really care about getting the indoor air quality in your house really good, you do all seven of those things.

KS

Kendra Seymour

40:30

Yeah, and we're gonna, we'll link to several of your blog posts that do a really nice job, kind of diving a little deeper into that, and people can refer to as a reference. So let's, let's kind of end on a note with your

book, like this title I thought was so thought provoking, A House Needs to Breathe, or Does It? so can, can I ask you, like, what inspired that your book and the title and stuff?

AB

Dr. Allison Bailes

40:54

Sure, yes. Well, that came from conversations with way too many builders who say, Oh, we shouldn't build houses too tight a house needs to breathe. And I say, No, that's absolutely wrong. But there are, there are people out there who are convinced that that airtight houses create problems. And yes, if that's all you do is create an airtight house and don't do anything about, you know, the other parts of indoor air quality, you can have indoor air quality problems most of the time when builders say that, they're just saying it's a complaint about having to spend money on something they didn't want to spend money on. And, you know, in the last 14 years, we now have a whole lot of states that require blower door testing for new homes. You build a home, you've got to have a blower door tester. You have to hit a certain threshold, and that shows that your house is pretty airtight. And the codes also say that if you get below you know this other number, then you need to put in a whole house mechanical ventilation system. Now, builders, of course, have a big influence on how the codes get implemented. So there's the model codes, like the International residential code, and then there's the state and municipality codes, depending on what kind of place you live in. Some states have statewide codes. Georgia is like that. Other states don't. Colorado, for example, what's called a home rule state. And in Georgia, we last updated our code six or seven years ago, and we went from an air tightness threshold of seven air changes per hour at 50 Pascals. So seven ACH 50. That's the a measure for when the blower door is running. You know how much air is moving through the house. So seven air changes per hour means in one hour, all the air in the house exchanges with outdoor air seven times. So in 2011 when we first adopted the code, our threshold was seven ACH 50. In 2019 I think when the new one was adopted, we went to five Ach 50. Well, the the model code says, if you get to below five ACH 50, which we're at, that you need to have mechanical ventilation. But the builders was first of all where we are. The model code said we should have been at three ACH 50, but the builder said, No, five ACH 50, we'll go down, but we won't go all the way to three. Okay, all right, five still better than seven. And seven is way better than what we were at before, which was like 10 to 15. So five ACH 50. And you know that's when the model code the IRC says, Okay, if you're below five, you need to have mechanical whole house ventilation. And the builder said, Well, you know what, let's, let's, let's drop that down to three. So in Georgia, there are a whole lot of houses being built where the air tightness is below five ACH 50, maybe even 3.1 ACH 50, and they've got no whole house ventilation. And that is a liability. If I were a builder, I would be afraid to sell that house, because you are now putting you've got liability there.

KS

Kendra Seymour

44:17

Yeah, because, because everything that is in that home is building up and staying trapped in that home. And for those listening, right, we're building our homes tighter now for an energy perspective, right? So we're not wasting energy. And for older homes, like my parents live in an older home that I'm will tell you, is very leaky, right? And but the I guess, the pro of that is that if there is some moisture penetration, it will dry out faster, but then they're wasting a lot of energy. And so then, when you we course correct, and we won't get into the history with the oil embargo and all of that and why we've made this energy shift, it's all about the balance. So does does the house need to breathe? Yes or no?

AB

Dr. Allison Bailes

44:59

No, it's on page 23 I don't keep people in suspense. No, you want an airtight house? And, you know, obviously we've said this already a couple of times, airtightness is one of those, you know, seven things for good indoor air quality. It's, you know, it's good for energy efficiency, it's good for indoor air quality. It's also good for durability, because when you have a leaky house, and especially in well, in a humid climate or a cold climate, a cold, dry climate, can have the same kind of problems if you, if you allow air to move through building assemblies like a wall, the the humidity can can get into that wall cavity and get accumulate on the backside of sheathing or the backside of drywall, and things get wet, they get moldy. The you know, starts rotting. So it's also good from a durability perspective.

KS

Kendra Seymour

45:55

Yeah, yeah. So leaky homes have issues as well. So again, it's about understanding what's going on in your home and working with a good, you know, building science minded professional, IAQ professional who really understands your your home as a system. I love it. I love the book. I love the idea that houses don't need to breathe, but we sure do right, and so paying attention to what we can do to make the air in our homes healthy, whether it's source removal, which I always say we start there, and filtration and ventilation and all of those things matter so much. So for anyone who had follow up questions or wanted to get in contact with you, or we mentioned your blog a lot, I know that's on your website. How could they do that?

AB

Dr. Allison Bailes

46:36

Yeah, so our website is energyvanguard.com and Vanguard is V, A, N, G, U, A, R, D, it's all one word, energyvanguard.com, we also have a YouTube channel. Look for The Energy Vanguard, and I've been doing

more with that in the last year. And we are very active on LinkedIn, and I have a weekly newsletter. So if you go to the blog on the right side, in the sidebar on the right you can, you can enter your name and email address, and you'll get our weekly newsletter. And I usually have one new article a week that that you'll see there, and also our book. You know, my book is available through through our website. We have a separate URL for the store. It's energyvanguardstore.com, you can buy the book there, and when you buy it from us, instead of Amazon, it will come signed. I I sign all those before they go out. Oh, you're welcome, my pleasure.

KS

Kendra Seymour

47:33

That's great. And we'll link to everything in the show notes to make for it easier for people listening. So if you're on our podcast or YouTube or watching from our website, you can just look into the show notes for show notes for for all of that. Thank you so much for your your time today and sharing your expertise. It is so important and so fascinating, and I appreciate you making what I think can feel like a very complicated, overwhelming topic, accessible even to just the average layperson like myself and homeowner and renter. So this is something if you're listening, you too can begin to understand, and the resources you provide are a great entry point for people. So thank you. And for everyone listening, if you found this interview helpful, do me a favor, head on over to changetheairfoundation.org, and sign up for our newsletter, because it really is the best way to get great information like this directly to your inbox. Thank you so much. We'll see you next time.