Home Testing: How Much Air Does Your House Leak

with Chris Hughes & Steve Rogers

SPEAKERS
Kendra Seymour, Steve Rogers, Chris Hughes

SR
Steve Rogers
00:00
Yeah, so why would you do a blower door test? There's two things that a blower door test does. Number one, it measures the leakage of the house, like, what's if you add up all the air can go through, all the leaks at that pressure, what's the total? So it gives you a number associated with how leaky the house is. The second thing is, if you have some other equipment, like an infrared camera, or even a device that generates fog, like almost like a like vape, you can actually, with a blower door, locate the leaks, which is really important, because once you find out if your house is leaky, or maybe your house is tight, but it has some leaks in really problematic places. Well, the blower door can help you locate where they are so they can be fixed.

KS
Kendra Seymour
00:56
Welcome to the HVAC plus D mini class series brought to you by Change the Air Foundation. This series is made possible thanks to the generosity of our sponsor, Santa Fe Dehumidifiers. We are deeply grateful for their support, which helps us continue raising awareness and providing free resources so that more families can breathe safe indoor air. A quick reminder, this 12 part mini class series offers a consumer friendly overview of common HVAC plus D topics. It is not a replacement for professional advice. You can watch the full series on our YouTube channel or by visiting ChangeTheAirFoundation.org and clicking on our resources tab. Welcome to episode four, home testing. How much air does your house leak with Chris Hughes and Steve Rogers. In this episode, we'll talk about how blower door testing and other equipment can be used to determine if your home or duct work is leaky. This episode takes a deeper dive into the science of pressure and airflow and helps you gain a better understanding of what might be coming in and

out of your home. A bit of background on our presenters, Steve Rogers is the president of The Energy Conservatory, makers of the Minneapolis Blower Door and Minneapolis Duct Blaster and True Flow. He has over 25 years of experience working in flow and pressure management at The Energy Conservatory, Dwyer and Emerson. Steve earned his mechanical engineering degree from Brigham Young University, and is involved in multiple committees for the ASME, ISO, and ASHRAE. Chris Hughes an experienced HVAC professional from the heart of Louisiana with 20 years of experience in the industry. In addition to his previous hands on experience as an HVAC mechanical contractor, Chris has further honed his experience through his time at The Energy Conservatory, where he continues to fine tune his skills and stay abreast of the latest advancements in HVAC and building science technology.

KS

Kendra Seymour

02:45

Chris, Steve, thank you so much for coming back. I am super excited for this part of this series, because I it feels very actionable and things that homeowners can start to do on their home with the help of a professional to start getting some data on their home and figure out what's going on. So why don't you guys jump right in?

CH

Chris Hughes

03:06

I kind of wanted to start this class with the notion of, like, who are we, and what do we do, and what do we care about? And so I kind of titled it as what testing house means to us, meaning TEC or The Energy Conservatory, and we're a pressure and flow company at specifically for buildings and air conditioners. So, you know, we have some core products that measure pressure and flow. And so we're going to step through what those do. And Steve will probably expand like the problems that relate to those, you know, home issues that arise that you may want to test for. So I may cover some of the testing, and Steve will maybe dig deeper about like why you want to or how you're going to notice that, and why you may want to have these tests. Our flagship product is the blower door, and so I think we should dive into that first, and what, what is a blower door test? And this is where we're taking a calibrated fan, and we're putting it in like a fabric panel that fits into an exterior doorway, and we are measuring the mass flow of air into the home and going out of the home. So that fan is either going to suck or blow into that home to either depressurize it or pressurize it. And we're going to measure a differential pressure between inside the home and outside the home to reach a test pressure. We're going to dig a little bit deeper in that in a few slides, but that is the the most simplest way I could kind of explain the concept of what we're trying to do with a blower door test.

SR

Steve Rogers

04:43

Yeah, so why would you do a blower door test? There's two things that a blower door test does. Number one, it measures the leakage of the house, like, what's if you add up all the air can go through, all the leaks at that pressure, what's the total? So it gives a number associated with how leaky the house is. The second thing is, if you have some other equipment, like an infrared camera, or even a device that generates fog, like almost like a vape, you can actually, with a blower door, locate the leaks, which is really important, because once you find out if your house is leaky, or maybe your house is tight, but it has some leaks in really problematic places. Well, the blower door can help you locate where they are so they can be fixed. So and the way, the way that that's done is that, you know, once we have the building at a stable pressure, typically it's tested at 50 Pascals. So when the fan speeds up and it gets the house to be at 50 Pascals. We know that all of the air that's getting sucked out through the fan, which we can measure, has to be equal to all the air that's leaking in through all the leaks. We talked in part three about the air going in has to equal the air going out, or the house would implode or explode. And so that's how we know that whatever air we measure leaving the house through the fan is coming in through all the leaks. And this is what the gauge looks like when the blower door test is happening on the left side, that 50 Pascal pressure that's shown there, that's the pressure of the house. We're just measuring the pressure difference between inside the house and outside the house. In this case, we're depressurizing the house. So it's at minus 50 compared to the pressure outside. And on the right hand side, it says that flow in CFM is 3,945 that would be a pretty leaky house, but that's how many cubic feet per minute of air leaks through that house if the pressure is at 50. And we should say that that's not how much airflow is leaking through your house all the time, because usually the pressure is not that high. We have to bring it to a little higher pressure to make the measurement, but that's the standard way that we report the leakage. Is your CFM, cubic feet per minute at a pressure of 50 Pascals. So this is what's shown on the gauge when you do the blower door test. This is the number that we get to that helps us understand, is this a leaky house? Is it a tight house? And then, of course, where are the leaks?

CH

Chris Hughes

07:28

I want to just expand a little bit further, because if I'm a homeowner watching this, I'm probably wondering right now, what is 50 Pascals of pressure? And so that is our test pressure, right? So there's a standard that we follow from, like the International Code Council. And I think I have a slide of that. So, like the International Code Council is has adopted a standard of a test pressure of 50 Pascals. 50 Pascals, you know, some people would say it's like having 20 mile per hour wind against your house in all directions, to give you some kind of concept of how much pressure that is, and trying to remember how Gary Nelson said it, who's like the founder of The Energy Conservatory, Steve, you may remember, like, why did we pick 50 Pascals?

SR

Steve Rogers

08:19

Because it's about right. The reason, the reason we do 50 is because if it was much lower, you'd have a really difficult time doing a test on even a breezy day, because the wind can create pressures on even on a lightly breezy day that are 10 or 15 Pascals, and so that starts to cause trouble when you're trying to measure at 50. So 50 is significantly higher from wind noise. But the other thing is, if it gets too high, then we have to worry about, well, are we going to start to blow the Tyvek tape off when you're testing a house that's got a house wrap on it. You know, could I be pushing on the windows a little too hard and, you know, bump something loose, and normally, nothing like that's going to happen until you're at several 100 Pascals of pressure. And so what this is, is it's a number that's high enough to avoid the wind and low enough to not ever damage any of the of the building.

CH

Chris Hughes

09:15

I'm going to expand a little bit further of what I would do with a blower door number if I'm an HVAC technician, because that's kind of like my background. Which, if I have a blower door number of 3,945 I am going to take that 50 Pascals of pressure and that blower door number, and the software will tell me, well, how much natural infiltration is going to come into the home, or natural leakage is going to come into the home at four Pascals of pressure, and that's what I'm truly trying to figure out, and that is going to sum up how much of the impact of load from infiltration I'm going to have to deal with to make that home comfortable. Okay? And we kind of covered that in part three, where we talked about infiltration. We're going to get into that a little deeper here in a second. But that is why, as in, like an HVAC person, I need a blower door test. I need to know what I'm up against, and that blower door number is going to help me do that.

SR

Steve Rogers

10:11

Let me just say one other thing about Pascals to help people understand how much pressure this is. It's really a tiny pressure, like Chris said, it's how much pressure is created by a 20 mile per hour, mile per hour, wind on your house. But also, a one inch of water of pressure is equal to 250 Pascals and inches of water is important, because everybody has a reference. If you've ever drunk a liquid through a straw, then you know a little bit about pressure, because one inch of water is how much pressure, how much you have to suck to make the water in the straw go up just one inch, not all the way to your mouth, but make it just go up one inch. That's the pressure of one inch of water. And that one inch of water is actually 250 Pascals. So if we're testing at 50, it's only 1/5 of that, so 20% of you know that's two tenths, just a little less than a quarter of an inch of water when you suck water up a drinking straw.

CH

Chris Hughes

11:14

And so a blower door test can be done like two ways. You can do a depressurization test and you can do a pressurization test, right? I think we might have talked about that earlier. So this you kind of want to make sure you hire professional to kind of test, because as you're changing the flow in your house, you need to make sure that the house is set up properly. Now I didn't add a ton of slides in for that, because I'm not trying to teach people how to run a blower door test in this presentation. I'm trying to make them aware of it in my why they may want it. But there's professional training all over the country that will teach you how to run a blower door test to make sure that you don't, you know, destroy the home when you do so. Like a good example of what I mean by that is, let's just say, if you have a fire burning or wood burning fireplace, and you don't, you know, bridge the doors or tape it up, and you do a depressurization test, and those doors come open, and there's tons of ashes everywhere, and somebody has carpet. You're going to have all of that, those ashes just be sucked, you know, right to the carpet, and you're going to make a big mess, and that's going to be a massive cleanup. And so there's lots of other things, but that's just one really easy example to making sure. You want to make sure the house is prepared properly before you just go put a blower door in the house and pressurize it just to get leaks.

SR

Steve Rogers

12:41

And there's some other safety considerations as well, but so consult with the professional that knows how to do the blower door test.

CH

Chris Hughes

12:48

Yep, so, and we're trying to get to three air changes per code. Now, here's here's something that's kind of fascinating when you look at how the countries ran. Like where Steve lives in Minnesota, Steve, I believe you're at three air changes per hour. That's your jurisdiction.

SR

Steve Rogers

13:07

Yeah. So that means a new home built in Minnesota has to have at less than three air changes per hour at 50 Pascals in order to pass code.

CH

Chris Hughes

13:18

Right, and so I believe, if I'm not mistaken right now, is this being is being recorded, my area in Louisiana is still at seven air changes per hour to pass code. And I'm just going to state the fact that that's not very good, like, that's not very good at all. Our building code air changes per hour should be decreased. We should be trying to achieve three air changes per hour, just like Steve. We're not doing ourselves any favors by letting the standard be very loose. And what what's happening is there is code meetings that happen per jurisdiction, and they get to vote if they're going to accept the newest standards or rely on the old standards, because the technical people of the world in that jurisdiction are not ready for it. And so when they vote that they're not ready for it, they, you know, they peel back to the previous standard, which was at one point 7 and so it's different in jurisdictions everywhere. So to find out where you're at, you know, you kind of got to call your jurisdiction and see what the current standard they're following. But it doesn't mean you want to have a house just pass code, because code for you might be seven, eight changes per hour. So if you're building a new home, you know, and let's just say somebody's on the 2017 code. I think it is maybe. Anyway, let's just say their their target is seven air changes per hour. That doesn't mean you can't go ask and have your contractor, you know, you tell them, hey, I want this house at three air changes per hour. You need to hit that target. That's what I want. That's what I'm paying you for. Make that a stipulation of the contract. Doesn't mean they have to pass code. Put up stronger contingent against that house.

SR

Steve Rogers

15:06

Yeah, I'll make, I'll make another statement that'll give some context. When somebody really wants to build a high performance home because they want it to be super comfortable, super good air quality and use very little energy, they're aiming typically for right around one air change per hour. There's a German standard called Passive House, which is super, super energy efficient. And their goal is, or they're not their goal, their requirement is 0.6 air changes per hour. So high performance, the best homes are in that, you know, 0.5 to one is if you want to build a really, really good home, that's where those ones land. So Minnesota, for example, is at three. That's your basic code. And yeah, I know Florida is at seven, Louisiana is at seven. Some of the other southern states are at five, which is better. But yeah, so just meeting code is not going to get you an awesome house depending on what state you live in.

KS

Kendra Seymour

16:02

Can I ask a clarifying question or a statement I guess. For those listening the like three air exchanges per hour. Is it correct to say that they can think about this in the sense that means that the the air in your home is turned over and replaced through roughly three times every hour. Is that an accurate way to describe it.

SR

Steve Rogers

16:21

Um, sort of let me explain air changes per hour. So this is air changes per hour at 50 Pascals. Meaning that would be a correct description if there were 50 Pascals of pressure on your house all the time. But there never is. That's only what we test at. So the actual number of air changes that happen is going to depend on it's, you know, Is it really hot? Is it really cold, is it windy, and that sort of thing, but the air changes per hour is, you take that CFM number that we looked at, that 3000 something number, and you divide that by the volume of the house, which will tell you how many times the air turns over, and then you have to convert it, because one is minutes and the other one is hours. So there's a minutes to hours conversion as well, but that air changes per hour tells you how many times the air would turn over in the house if it was leaking at 50 Pascals.

CH

Chris Hughes

17:17

Now I may add one quick tidbit to this before we go on. And there is rules that you have to follow. And I want to this comes up a lot, so I feel like I need to address it. When you get below three air changes an hour, the code will state that you have to add mechanical ventilation to the home. And some builders might would say, well, you don't want to build a house too tight because then we're going to have all these situations where we have to add mechanical ventilation, and it comes with its own headaches. And that should not be the reason you don't build a tight home, right? You don't want to build a leaky house because you don't want to add mechanical ventilation. You should build a tight home and add mechanical ventilation. And you should think about mechanical ventilation strategies that are going to work well for that home. And that doesn't mean just run a duct into the house so it can suck freely outside air, as we covered in part three, that probably wouldn't be the best idea. There's strategies, and that's where good HVAC technicians know how to look at a moisture balance calculation and make good decisions for your mechanical ventilation. You'd want your mechanical ventilation to be filtered and treated, not just coming through your attic insulation pouring into your home because you didn't want to build a tight home. Okay, I'm going to pass this one to Steve, but I'll I'll kick it off for you. There's two houses side by side, right here, but they're not exactly the same house. So the question you should ask yourself right now is, what is the difference between these two houses?

SR

Steve Rogers

18:49

Yeah. Can you spot the difference?

CH

Chris Hughes

18:52

If you want to have fun, you could pause the video and look at it before Steve gives you the full brunt answer.

KS
Kendra Seymour
18:59
So this is not a trick question, right?

SR
Steve Rogers
19:04
It is and it isn't,

CH
Chris Hughes
19:07
All right? So if you pause the video and had fun with it, great. Steve, kick us off.

SR
Steve Rogers
19:12
So the first house is at 2.9 air changes per hour, which means it's leaking about 1000 CFM at 50 Pascals. The one on the right is leaking 13 air changes per hour. It's leaking about 4500 cfm, 50. So the difference between these pictures is something you can't see. So it's kind of a trick question. It's the same photo, but you can't look at a house and to know how leaky or airtight it is. There are some general trends, like older homes tend to be leakier than newer homes. But that's not always true. There's some big new homes, some nice new homes that are really leaky, and there are some old homes that are pretty airtight. And so what we should be thinking about is, what does that leakage mean about the house. So the one on the left, you can think of, it's like your house is a Yeti cooler. One of the high performance, it's going to keep your cold food cold forever. And the one on the right is about as airtight as a laundry basket or a hay barn. And what does that mean for heating and cooling your house, and what does it mean for air quality? Because it means something for both of those. So we talked about that the one on the left, at 50 Pascals, leaks about 1000 cubic feet per minute, but that's only at 50 Pascals, and that's only going to happen because you're running a fan or it's a rea,lly windy day. On a natural, under natural infiltration, meaning there's no fans sucking or blowing. That house is going to leak about 38 cubic feet per minute. That's not a lot. That means that the infiltration load is point one six tons. And you know, as Chris talked about before, a typical for typical size home, a two ton or three ton air conditioner is going to be what that home has. Meaning that if this is a two ton or three ton air conditioner, point one six tons is only a tiny fraction of what you're doing with the heating and cooling. That has to make up for the fact that there's a little bit of natural air leaking through the building. So the one on the left is really a good situation. Let's compare that with the

house on the right. Okay. Oh, and up at the top, that 2.7 tons, we're saying that's the total cooling load for that house. Meaning, when you calculate how much cooling that house needs, it needs 2.7 tons. So a technician might say that's close enough. We'll go with a two and a half ton, or they might go with a three ton, depending on some other factors, but that's a 2.7 ton house. The one on the right, just because it's leakier, otherwise identical, it needs 3.3 tons of cooling. It needs, you know, almost a ton more. And that's because on that same 95 degree day, just from natural infiltration through the home, there's going to be more like 170 CFM going into that home, all whenever it's warm. Meaning the infiltration load, or how much of the air conditioning is needed, just because the house is leaky, it's almost three quarters of a ton. So a large percentage of that cooling that's needed for that home is just to cover the leakage. And if you if you probably don't have a picture of what's 170 CFM like? Well, 170 CFM, that's probably how much air you're blowing into, maybe through two vents in the master suite of a home. That's quite a bit of air, but now imagine that you've got two vents worth of air going into the house, but it's leaking from the outside at 95 degrees, and the air conditioner has to compensate for that much hot air going into the house and bringing humidity with it. We won't get into sensible heat ratio below. You know, that's just a matter of how much cooling versus dehumidification does the system need to do?

CH

Chris Hughes

23:36

I could, I could take a stab at that Steven, okay, sum it up. I think an easy way. If I'm an HVAC technician and I'm asking myself, do I want to run a blower door on this house for maybe a project that I'm scoping out? If I took a blower door and I ran it on the first house that's a house that I can control. I can control the temperature, and more importantly, I can control the humidity in that home, and that's what a customer wants to hear from me. It's, as an HVAC person guarantees are not something we we jokingly give out in a contract. A blower door lets me know if I could probably pull that off. If I tackle the house on the right, if I run a blower door on that house, and I know that house is at, let's just say, 13 air changes an hour. There is no way I am going to put a guarantee on that house that I'm going to control the moisture, unless they're ready to open their wallet and spend a lot of money on dehumidification, which they will not do. It will be very expensive, and they're not going to want to do it. And even if you do that, there's a chance that you won't control it as an HVAC tech. You don't put guarantees on leaky houses. You can put guarantees on tight houses.

SR

Steve Rogers

24:46

Well, furthermore, it's probably cheaper for them to actually air seal the house and get that number from 13 down to something that's, you know, if you can get it down to five or, you know, five or six air changes per hour, you'd have much better chance of keeping it comfortable. So with that example, I have to give my my favorite Chris Hughes quote. And as an HVAC contractor, Chris very often had conversations with homeowners about expectations of a new system that they wanted Chris to install. And in one particular conversation, Chris was having a conversation with the homeowner, describing what they expected out of the new system, and it was clear that they wanted perfection. And so Chris said, Okay, so let me understand what you want out of this new system is you want perfection? And the homeowner said, Yeah, Chris, that's exactly what I want. I want perfection. And Chris had said, Well, unfortunately, you didn't buy that kind of home. And so true story. And Chris is a, you know, Chris is a good people person. He knows which homeowners it's okay to say that to and which ones you probably don't want to say that to. But that's the bottom line. Is that if you if the house is so leaky that you can't really control things. A new system is not going to fix it.

CH

Chris Hughes

26:04

I think if I'm a homeowner and I'm gonna try to I'm gonna try to make this very relatable for a homeowner in a conversation to have with their technical excellence that shows up there to help them out. What they're looking for and asking for is permanent load reduction work, right. Like air, sew my house, add insulation, get my laundry basket to look more like a Yeti cooler. And the industry hasn't always had, well, let me, let me back up. HVAC technicians do not get asked for that. That is also not what they are geared to do coming out of trade school. And who they're who they're learning from, is not a core group of people who have been focused on that, generally speaking, but there is a movement happening, and we're trying to play a role in that movement, to encourage them to either take that on as another role and expand their business model, to offer it, or partner with somebody who is very good at that. You have weatherization crews around the country that focus on permanent load reduction, and you should, if you want to get into this and making comfort you know, part of your business model with permanent load reduction work partner with a specialist who does that so you can go do the research, have a design, have a quality install, have a comfortable home. And so if you're a homeowner, you're asking for, hey, you know if, if you're being presented with an air conditioner replacement and you've had an uncomfortable home, because maybe you live in a problematic house, maybe you should be talking to that HVAC technician about permanent load reduction. If they don't know there you have one or two choices. You could step in, ask him to source some information, and if he's willing to play ball and say, Hey, let's figure this out together. Because more than likely you're there's a chance you won't find one that's been introduced to this yet. So you may have to work with him and he have him be open minded, but if he's very strong and aggressive to say I don't know what

you're talking about, and I don't want to deal with that, then you may have the wrong choice on your hands. So think about that when you're dealing with a home that's has high humidity problems. So let's switch gears. Let's go into Duct Leakage Testing. So we do make a product that tests duct leakage, and we kind of tapped into that in part three, and now we're really diving deep into part four, and so that also has a code standard to it.

SR

Steve Rogers

28:31

Yeah, let's just hit that number in the middle the rough in with an indoor unit being less than four CFM at 25 per 100 square feet of living space. Okay, it's that per 100 square feet of living space. That's a little bit of a problem for people to follow. But let me help you with the math. If you got a 2000 square foot house, you take 2000 and divide it by 100 and you get 20, and you multiply that four CFM by 20 and that gives you the 80 CFM we talked about in the last part. That means that, according to code, in most states that require duct testing, if you've got a 2000 square foot house, it has to have duct leakage under 80 CFM, total duct leakage. If it's a 3000 square foot house, then the same math would work out to be about 120 CFM of leakage at 25. So that's the and the test is normally done at rough and with the indoor unit. But if the indoor unit was not installed yet, meaning they installed the ductwork, but they didn't install the air handler or the furnace yet, then they would have to get it to three, which is going to be, you know, 25% less than what I just said. Or if they do the test after the construction is complete, then it would still be the same for CFM per 100 square feet of living space.

CH

Chris Hughes

30:00

You know, we don't test for duct leakage outside, which is or for code, we don't test for that. So I want to kind of expand on what the differences is, because we talked a lot about total duct leakage outside in part three. So when we're doing a total duct leakage test, we're testing the entire HVAC system, from the return air grill to the piece of equipment installed, the supplied duct work, down to the supply registers, right? We're just like the house we were either pulling a vacuum or pressurizing. We're doing the exact same thing, except we're doing doing it to all of the HVAC equipment, and we're testing it at 25 Pascals of pressure, which is half the pressure of the blower door test. And that is just, you know, following the mantra of what we talked about with the blower door test. It's all the pressure we needed to test that. So that is a total duck legged test. And what I'm simulating in this picture is I drew a red line on the screen, okay? And what that red line is a line around the air barrier. And in the builders community, this has become a trend where they take a red line when they're taking their blueprints, and they'll draw a red line around their air barrier. And that's kind of like a good builders doing that to make sure that he has a continuous air barrier. And they call that like the red line. They draw the box. And so what I've done is I've drew a box around the continuous air barrier of this home. Now what the red arrows represent is leakage

from the duct system that is outside the air barrier that is duct leakage to outside that is going to cause the double whammy effect that Steve talked about in part three. The blue arrows represent duct leakage that's happening inside the air barrier, so it leaks, but it's staying inside the envelope, so it's not as impactful, meaning it doesn't have the double whammy effect. Okay? So when you add up both of those duct leakages, both inside the envelope and outside the air barrier, that is total duct leakage. So when you're measuring both together at one time, that is what you're taking to the International Code Council standard and comparing against. Switching gears, let's just say we've built the house. The house has had, had a blower door test, the HVAC got installed. It got a duct leakage test. And now we're in the home, and the we turn the air conditioner on, and we want to maintain, you know, some level of balance, right? Like a lot of people will relate the air conditioner to the home as the heartbeat to the body, right? What keeps the body like going without falling apart? And the HVAC community would say that's the air conditioner. And I alluded to this a little bit about airflow and how important that is in part three, and now I'm going to expand on it in part four, right here. So we do make a tool. It's called the True Flow Grid, and it measures total system airflow. Meaning all of the airflow that's moving through the air conditioner that is moving air. Well, for this example, we're really focusing on air conditioning. So we're talking about all the airflow moving across the cooling coil of the air conditioner. And you want to know airflow, because airflow is going to dictate that whole water removal versus sensible heat. But to expand further is we want to check the pressure of the duct system as the airflow is moving through it. And we do that by measuring what's called the static pressure. And we'll measure that in inches of water column, which Steve gave a great example about where, when you're sucking from a straw, you know, and you go up one inch, that's one inch of water column. And so you know both of those matter, and they matter for different reasons. So we've talked a lot about air flow and removing moisture, but if your pressure is too high and your air conditioner is struggling to move air flow through the ducts and the pressure is really high, that's a lot of work on the fan motor. And so a fan motor is only going to push so hard for so long until it just dies, because there's an electric motor in there. And if it's under a lot of stress, the wattage goes up. And when the wattage goes up, the motor struggling, and the motor will burn itself out. And so high pressure is going to lead to early failures of fan motors, and that's a particular type of fan motor. And I hate to get too nerdy, but I feel like I gotta do this. There's different types of fan motors. There's ones that will push, push, push and kill themselves, and there's different types of fan motors that say that's all I can give you, and there I'm not going to work any harder for you. And in air conditioners, with those type of fan motors, the opposite thing will happen. You will have lower wattage because you'll move less flow, and then that will result in the cooling coil apparatus to turn into a block of ice. It's going to freeze up because you're not moving enough airflow across it. So in a nutshell, a lot of bad things are going to happen to your air conditioner repeatedly if you have improper flow or high pressure. So you want to try to test the heartbeat of the home, which is the flow of the air conditioner. Okay?

SR

Steve Rogers

35:40

And you can think about that, it's a lot like when you go to the doctor, and they always measure your blood pressure. If your blood pressure is high, well your your pump isn't going to last as long. In that case, your pump is your heart. But with the air conditioning system, it's the blower fan, and if your static pressure is too high, then it can, it can cause difficulty. So in terms of making sure the equipment is operating correctly and is going to last properly, both the airflow and the static pressure need to be in that green zone, in that good zone, or you can have, you know, poor humidity control number one. But even worse, it can make your equipment die prematurely.

CH

Chris Hughes

36:28

And this is another one of these things where it's it's nice to hire a knowledgeable technician who understands that different equipment will have different ratings that are allowed. So, you know, not all air conditioning manufactured equipment is going to respond the same way. Some have a little bit stronger motors, some have weaker motors, and a good technician will know how to dig into what's called the original equipment manufacturers data to know what that fan motor can handle and then test to see how it's doing against that. Okay, so looking at this slide, we're going to focus on that main sentence, low air flow is comfortable, but it's not efficient. And if you have a house that needs more water removal capacity, then you're taking the air conditioner and you're moving the fan speed at an acceptable lower rate. Now you're removing the energy efficiency factor of that air conditioner, because at a higher flow, it'll be more efficient. But you want to control the humidity in the home. You don't want to as a technician, you don't want to tell a homeowner, Hey, I just gave you this air conditioner, and it's awesome, and it's super energy efficient, and then have them calling you all the time saying, hey, it's very uncomfortable in my house. Nobody wants that phone call. Yeah. So in this scenario, controlling humidity is key. That should probably be the first thing you focus on, and the efficiency should be second. So you know, lower air flow is going to control humidity potentially, but there's a limit to that. You can't just bottom it out at a really low flow and expect to get comfort no matter what there's there's a balance there,

SR

Steve Rogers

38:09

Right? Yeah, as you get lower below about 350 it's not removing any more moisture anyway, and it's endangering the life of the equipment.

CH

Chris Hughes

38:18

True, and this is getting a little in the weeds, but you know, these are nominal numbers we're using, and you'll find with some of the newer equipment, inverter based equipment, and that may not mean anything to a homeowner right now, but like, these are nominal numbers. So this is where having the right technician who really knows the equipment manual inside and out really comes into play, because 325 may be totally okay with that brand, but it may not be okay with another brand. Looking at the second slide here, we talk about high air flow is efficient, but it's not very good at removing moisture. So if I have the fan speed and I just let it rip, right? I'm moving in this example, 450 CFM per ton. Well, I'm going to have an efficient air conditioner, and that's great, but I may not remove the moisture I need to in the home, which means I'm going to have a very uncomfortable homeowner, and that's going to lead to callbacks, callbacks, callbacks. So if you know, if you're dealing with that, getting the fan speed checked by the, you know, HVAC technician would be a good first move.

SR

Steve Rogers

39:26

And one thing to consider here is this might be that higher airflow might be the correct airflow. If you live in Nevada or someplace in the southwestern states where it's really dry, you don't need to do a lot of dehumidification, because, you know, the air that leaks into your house is never humid.

CH

Chris Hughes

39:41

And then that brings us to, you know, the last slide is proper airflow satisfies both comfort and efficiency. So you know, now there's some edge cases here, and there's a lot of examples where the air conditioner just may not be enough to tackle the problem. You may need supplemental dehumidification in some scenarios or something like that, but it should start with the air conditioner. You shouldn't be buying supplemental dehumidification if you have an air conditioner that should be able to tackle the problem by itself. Now that's not always going to be the case, but you would hate to know that you have supplemental dehumidification when you didn't have to have it, right? So having an air conditioner that's set properly for the fan speed, that can tackle both comfort and efficiency, that's really what you want, and you want somebody competent enough that knows how to set this properly and explain it to you that way, you know you've gotten what you paid for. Now, moving on to the last topic that we're going to cover in this class, and that is checking for room pressurization.

SR

Steve Rogers

40:43

So room pressurization is a test that we do, because it's going to tell us if the original HVAC design allowed the air. So each bedroom, for example, has air going in to keep it warm or cool. But in some HVAC designs, and this is normally the original design, there's no way for that air to get back out to a central filter grill without going through a door. And so what happens is, if there's no pathway for the air to return, the bedroom gets pressurized whenever the door is closed. And that also means that the main living space where the filter grille is sucking the return air into the system actually gets negatively pressurized if the bedrooms go positive pressure, the rest of the house goes negative pressure to compensate. And so that means you can have a situation where all the bedrooms are positively pressurized, and the main living space is negatively pressurized, meaning that in the bedrooms, you're pushing air into there, and then you're just blowing that conditioned air through all the leaks. While in the main living space it's negative negatively pressurized, which means that all the leaks are leaking inward. So you're you can actually have part of your house under positive pressure and part of your house under negative pressure, meaning you're drawing air in from outside while you're blowing air to outside, and this can cause some of the problems we talked about with humidity, particularly in the main living space. But the other thing that it does is, if the bedrooms under quite a bit of pressure, it actually will reduce how much airflow goes into that bedroom when the door is closed compared to when the door is open. So technicians that really understand this, they are the and they talk with the homeowners or the renters in a home, the key that there's something wrong here is when somebody says, you know, the bedroom is comfortable all day long, and then when I go and close the bedroom door at night, it just gets, you know, it's not, it's not as comfortable. And that could be a sign that closing the door is reducing how much air, you know, how much cool air or heating air gets into the bedroom at night, so it can cause problems with the building envelope. It can cause problems with comfort, particularly when the doors are closed. And it can, you know, cause those same things that happen when you depressurize the house because of duct leakage.

KS

Kendra Seymour

43:15

So is the goal to be neutral. You don't want your house or any individual room under negative pressure and others under positive pressure. So is your goal to to be neutral.

SR

Steve Rogers

43:25

The goal is to be neutral, but you rarely achieve that. So even in parts of the country where we put a return duct and a supply duct in every bedroom, they don't always come out perfectly. My house in Minnesota, it's almost every house in Minnesota has a supply and a return in each room, but I have some bedrooms that are still under a little bit of positive pressure, and some that are under a little bit of negative pressure,

because there's the return is sucking a little more air out than the supply is putting in. And so the goal is to be under about three Pascals. So if you and that test is done, just like we show here, what this shows is the manometer is in the main living space, and you hook the hose to the manometer, you just put it under the door of the bedroom and close the door. And in this case, it's measuring 5.1 which isn't crazy. We've definitely seen worse than that, but that's a little higher than it should be. You typically want that to be under three Pascals. You typically won't have many problems if it's that low.

CH

Chris Hughes

44:26

Like Steve said, if you can achieve zero, awesome, you know, but it may require, like the door coming off the hinges in some scenario, not always, like having to go there. Now, here's my ad that I like to throw in here. I don't want a homeowner to watch this and have a technician come out and they start to see five or seven and think, oh, man, I need to take action if your home is not having issues and you have seven Pascals of pressure that is not a cause for action, but if you have an uncomfortable room or something else going on, and then you measure seven, well that might be an good indicator that there is action that needs to be taken. So I like to I like to say, if you're having issues, and you find that you have a room pressurization problem, well maybe you just found the identifier to that problem, but if you're measuring a little bit of high pressure and you're not uncomfortable, then, yeah, I don't know if I would start, you know, starting to do jumper ducks or anything like that. So it's one of those diagnostics that can help you if you're having issues, but it's not a diagnostic you should just do arbitrarily if you're not having any issues,

SR

Steve Rogers

45:41

And depends a little bit on the pressure. If all your bedrooms are above 20, you might want to think about doing something even if you're not having comfort problems. Like you know, and the simplest way to solve this, if you're okay with it, it's just leave the bedroom doors ajar at night. But the funny thing is, if you try to leave in these houses where you got bedrooms at 20 Pascals, you would try to leave the door one inch open, it will blow closed.

CH

Chris Hughes

46:07

To Steve's point, if you're having 20 Pascals of pressure underneath every door in the house, I will promise you you'll have issues. You'll you'll be living in a problematic house.

KS

Kendra Seymour

46:17

Yeah, yep. So those things you're talking about just pour into air quality and moisture and possibly mold and all those things,

CH

Chris Hughes

46:23

Probably an energy penalty that you're going to notice. You know, you're going to pay a utility bill that's higher than you want to. So getting into how that works, like Steve said, very simple test. You take the manometer, you set it off to the side, little bit away from that doorway, and then you slowly open the door with the roomulator, that looks very much like the size of a credit card. And we did this to kind of make this tool very cheap. And you put it in the crack of the door, and then you open the door until the gauge reads three Pascals of pressure. Now that doesn't necessarily mean when you put the jumper duct, transfer grille, which we'll talk about in a minute, that doesn't mean that once you install that, the room's going to be at three Pascals. It'll more than likely be less than three Pascals. So there's a buffer

SR

Steve Rogers

47:15

Let me interject something here. I think there's a piece of context information that we skipped over really quickly, and that is the way that you fix a bedroom that's getting pressurized is by adding a duct that usually goes through the attic from the bedroom ceiling into the ceiling of the hallway, and that lets air pass from the bedroom into the hallway. Or you can put a transfer grille usually done in the wall above the doorway that just lets air pass from the bedroom into the hallway when the door is closed. So the other third way that it can be done is by undercutting the door. So if you cut the bottom off the door and make the gap at the bottom of the door bigger, sometimes that's enough, but sometimes you'd have to cut it off, like five inches, and nobody wants that.

CH

Chris Hughes

48:04

And so what we found was this was kind of a blind spot. A lot of people aren't looking at this, and this is probably more of a southern problem. I haven't always toured the country and talk to HVAC with everybody around the country. I learned that when I came to Energy Conservatory, dealing with our HVAC customer base, I started to learn that, wow, up north, many systems are ducted returns. And in the southern area that I live in, rarely will we see a ducted return. And so in the non ducted return space, you see a lot of room pressurization issues, and so it's a blind spot, and a lot of people aren't addressing it, and it can lead to a lot of comfort problems. So that's why we kind of came up with this, you know, simple credit card to kind of

help out in here. It's to help people size that passive return, and this is how it works. So step one is you're just basically taking that measurement that you got from the crack of the door, and you're finding it in the column of step one. So let's just say, for instance, we measured a three quarter inch door gap when the gage measured three Pascals of pressure. We're then going to go follow that line to step two, and that's going to tell us the approximate CFM that we need to move from the bedroom to the main living space. And then step three is just some calculated different ways of how you can address that repair. If you need to move that air, you could do a round transfer duct, which, like Steve said, that's the jumper duct that goes in the ceiling from the bedroom ceiling to the main ceiling. You could do a transfer grille, which is like a through wall type of grille with a grill on both sides. And you know, we size that for you. Now you'll notice we also get into the door undercut clearances. Now this is, you know, how do I want to say this. The opportunities there for you. Now, I probably wouldn't cut my door three inches off the bottom, but somebody may want to, but we knew nobody would probably want to go bigger than that. So you'll notice we left at an inch and a half. We left that blank. We did that because we didn't feel anybody wants to go there and cut, you know, a quarter of their door off the bottom. So we would kind of like say that's the no fly zone. Okay

SR

Steve Rogers

50:41

Well, and it might be even higher than that, or you might be even farther up. So in Chris's example, the three quarter inch one. So look at the 30 inch door that says you need a door undercut of 1.8 inches. But that's 1.8 inches more than it has now. So if it had a door undercut of an inch already, this means you gotta go to almost three to get the air out. So that's made probably more than than most people want to do. That's, that's is, this is how much more undercut you need, not the total undercut you need.

CH

Chris Hughes

51:16

And so, very simplistic tool, right? Just kind of a quick little way for a technician to kind of size that jumper duct. Something that needs to be explained is the size of the duct that we are recommending. HVAC technicians are going to look at this, and they're going to say 150 CFM needs a 14 inch round. That is a very large duct. Why would I do that? Remember the goal? We're trying to keep the bedroom pressure comparatively to the main living body, below three Pascals of pressure. We're trying to pop a bubble. So we don't want this transfer duct to become more resistance that's going to apply to the air conditioner. Okay, we're trying to let the air freely flow with almost no pressure, and to do that, we need to size this duct very large. That is what we call a passive return, not a ducted return. A ducted return is something that ties directly back to the blower cabinet of the air conditioner, and that then becomes part of the HVAC design. If it's a jumper duct or a passive duct, that is something that does not need to be included into the HVAC design, and it will not get related back to that whole airflow static pressure dial.

SR

Steve Rogers

52:43

I'll just explain it a slightly different way. An HVAC designer probably knows that to move 150 CFM, they would normally do that with a seven inch round duct, or maybe an eight inch round and so they look at a 14 and go, that's way too big. Why would I need to do that? But keep in mind, when they're moving air in the supply, it's under a lot more pressure because of the fan. In a passive return, we're trying to move a lot of air with a tiny, tiny pressure. If the pressure difference between the bedroom and the hallway is only three Pascals, that means we have almost no pressure to move that air with, which means we need a much bigger duct to be able to move it. So it's just because there's, like Chris said, it's part of the HVAC design, then we're moving that air with the fan that's in the furnace or the air handler. And when you don't have a furnace or air handler to move that air with, you need a much bigger duct.

CH

Chris Hughes

53:38

So that's what testing a house means to us, right? We're a pressure and flow company, and we're geared toward residential, multi family, high rise buildings, and we're looking at the shell, the HVAC duct, and we're looking at basically zones, right? When you close the door and that pressure in the room becomes a different pressure than the room you're standing in, you've now created two zones, and they're at different pressures. And so we're trying to look at all of those aspects and make sure they work together and they work properly.

KS

Kendra Seymour

54:12

I loved this. This was so informative. Your your pictures and stuff were great. And I'm I'm a big fan of understanding your home and getting data before you make any big changes and purchases, because it can save you a lot of time and money and headache in the long run. So without, I don't want to open Pandora's box here, but if someone's listening, who should be getting and when I should say, this type of testing done, because this is something you're going to pay for separately as a homeowner, this isn't done as like part of your free estimate when they're coming out to do something. So is this something only people in leaky, older homes? Is it something people in tighter homes? Is this something everyone should do before they replace their system? Kind of help us understand who and when this type of testing would be suggested.

CH

Chris Hughes

55:00

I didn't really have a great understanding of this quite like I probably needed to before working for The Energy Conservatory. In working for The Energy Conservatory, I've gotten to learn a lot about the National Comfort Institute, and something they teach heavily on is combustion safe, safety and making sure that the home is safe from appliances that have combustion. So when you say, who would want to have this testing done? I haven't heard a lot of horror stories in my life, but I've heard a lot from them, and this kind of freaks me out, is you could be backdrafting combustion appliances, and those gasses could spill into your home, and you could be getting sick. Some people die. Some people just get mildly sick, and it's it feels chronic, and if you're dealing with that, you could use a lot of these test methods, and they have more that could figure out if this home is safe, and that's probably where we should start make sure the home is safe. That way you could live in a home that's not going to kill you. Now, Steve will probably go way further than me, but that's just something that I feel like I have had beat into me through the partnership with them that I found really intriguing.

KS

Kendra Seymour

56:22

Can you, for the listener, like, give examples of combustion products, because you're talking, I'm assuming, about things like, if you have, like, a gas water heater, right?

CH

Chris Hughes

56:32

If you have a natural draft gas water heater, that is a very easy appliance to backdraft

SR

Steve Rogers

56:39

And so, if you have a natural drafted water heater that's inside your home, if it's in your garage, this is probably not a big deal. But in the Midwest, all across the Midwest and in the northeast, you know your water heater is typically in the basement or somewhere else inside the house to keep it from freezing. So that's where, and we should also describe most homeowners can't look at their water heater, and know, do I have a natural, drafted or a power vented water heater? And the difference is, if you look at the top of your water heater and you see a cone that goes into a duct, and there's a gap between the cone and the top of the water heater, where you can see, you know, into that gap that's a naturally drafted water heater. And naturally drafted means that it depends on the hot gasses coming out of the water heater to create the lift that takes the gasses out of your house. If you look at the top of your water heater, you don't see a cone shaped thing and or that has a gap in it, if instead, you see something that looks kind of like a blower or a

fan, and then there's a PVC pipe, you know, plastic pipe coming out the top, and that's where the gasses go out the top. Then that's a power vented water heater. And you don't have those combustion safety concerns. If you see neither of those two things, your water heater is probably electric, and you don't need to worry about this.

KS

Kendra Seymour

58:07

Yeah. And to just further add context for listeners, this is where you start getting into like, like carbon monoxide issues, even like, low level carbon monoxide issues that you know can be deadly. You can't see it, you can't smell it. And so there is real concern there. So I appreciate that. Let's start with safety.

SR

Steve Rogers

58:26

Yeah, so I agree with Chris that number one is safety and other combustion appliances. So water heater is the number one. You might have an older furnace that's naturally drafted. You might have a gas fireplace, and even your gas range in the in the kitchen. I mean, actually, there's no draft on those unless you have a kitchen range hood that's blowing the air outside, and they don't always. So those are things you should be concerned about with combustion safety. Carbon monoxide is the worst thing, because you can kill you in a matter of minutes. But even there's other combustion products that are not as dangerous, like oxides of nitrogen, the NOX, NOX, you can look up the health effects of that, that can be, you know, something that's that's causes asthma, respiratory irritation and other symptoms like that. So combustion safety is the number one thing. Then from there, I think you want to be thinking about, you know, are you having comfort problems that you can't explain and you have a suspicion that maybe it's not the HVAC system itself? Another situation is, many states have incentives coming from the government to upgrade from a furnace to a heat pump. If you're thinking about getting a heat pump and you're in a you know, moderately cold to cold climate, you might think about having some of this done just to make your heat pump install more successful. Heat pumps can't generate as much heat as furnaces typically, and so if you want to get a heat pump in a colder climate, it might be a good time to think about, Well, should I do some insulation and air sealing so that the heat pump will have a better time of it? Or if I want a heat pump and my ducts are in outside of conditioned space, it's going to be much more successful if I make sure those ducts are sealed first. So if you're having heat pump, if you're having comfort installs, if you're having some some health problems you know that might be related to some of these things, you know, do some air quality monitoring and find out what's in your air and is this maybe something that's coming in from the outside, or something that's not getting, you know, taken out and it's coming from the inside. If you're having humidity problems. It could be duct leakage to the outside. It could be an oversized system, or just that you have a really leaky house.

KS

Kendra Seymour

1:00:52

Yeah. And I would encourage listeners like this is, this is something that you would pay for. It's not outrageously expensive when we talk in the grand scheme of things, and it can give you really helpful data. I've had this kind of testing done on my home. It's helped me make some really intentional choices. And for those listeners who are kind of coming to this with the mold and water damage, background, Steve, I think you at the beginning pointed out something really interesting. And when I had blower door testing done on my home and he had theatrical smoke, we were able to see that there was a recessed light, and I had an attic above and while it was under negative pressure, and I watched the air coming in from the attic through the recessed light, and we knew that we needed to seal that. And I've seen situations on the remediation side where you start to see the condensation, you start to see microbial growth around, can lights or bathroom vents or things like that. So it can be a tool that can kind of make the invisible a little more visible. You can be proactive, hopefully get ahead of some of these issues. So there's, I think there's a number of reasons that someone might choose to do this. So thank you. This has been incredibly helpful. Is there anything that you didn't say that you want to mention, or a point you just want to reiterate for listeners before we sign off?

SR

Steve Rogers

1:02:09

Yeah, I've got one more thing. So if you want to have some of this testing done, the very first thing I would do is check with your power company, because most of these tests also save energy the power company likely, not, not likely. But many parts of the country, the power company will have a an energy audit they can do that will often include a blower door test, and because it's part of what they need to do to save energy. A lot of times it'll be really cheap. Here in Minnesota, Xcel Energy has they can have the Home Energy squad come out and test your home for like, 100 home for like, $100 which is, you know, super cheap. And there's like three levels of testing, and the the middle and top tier have a blower door test included. The lowest tier is, is cheaper and doesn't include a blower door. But they'll, they'll do at least some of this testing with power company energy audit. And so that's a good way to look at if you want to get want to get started, see if your power company has a program.

KS

Kendra Seymour

1:02:59

Yeah, and that's helpful. I'm glad you mentioned that with home energy assessments and people going after certifications and things like that, this is often part of that. Thank you both so much for being here. I truly appreciate it. I know you guys work directly with professionals, and so if a professional wanted more information, you know, they they like what you guys are talking about. Is there a website or anything you can mention that? I think we'll link to it in the show notes.

CH

Chris Hughes

1:03:30

If you are a professional contractor, whether you're building science or HVAC, you know, reach out to us. We'd be happy to help you get on the right track. We are not a national certified training company. We work with those agencies to make sure they have the right gear, to make sure they have prop, you know, they may lean on us a little bit for manufacturer specific tool advice to apply in their trainings. So, you know, we're not going to be handing out the certifications. That doesn't mean we don't have equipment specific training. So you know, if you're looking for a good place to just get grounded on how the gear works before you go to a national certification training, just to have a maybe a quick little leg up before you go into that type of training. We do offer that at our website, there's a learning management portal where you can go in. It's free. Watch us kind of give you the basics of our tools and how it applies. Now, if you are a homeowner and you want just a better understanding of what these tools are going to do for you, we do quite a bit of advocacy. You can see that in our YouTube channel, where we'll go tackle homes. For example, we just did a home with Community Housing Partners, and we did a an overhaul to a home where we kind of had a house that had a lot of problems, and we went in there and kind of did the whole building science. and HVAC sweep and looked at everything from humidity to radon to we fully encapsulated the crawl space. And so if you want to get an understanding of what all that work looks like, we've got some video content you could watch and get a better understanding of what to ask for.

KS

Kendra Seymour

1:05:16

Wonderful and we'll link to all that in the show notes. Steve and Chris, thank you so much. Everyone listening we so appreciate it. We hope you come back for part five, because we're going to tackle HVAC design. That's going to be a two parter. And we're going to talk about, is your unit too big, too small, just right? We're going to get into things like Manual J, S, D and T. And I know right now that sounds like alphabet soup, but I promise you, we're going to make it clear, and we're going to talk about why you need to be thinking about those things. So if you don't want to miss an episode, here's how to stay connected. Hit the Like and Follow button on our YouTube channel. You can also visit ChangeTheAirFoundation.org, and click on our resource tab. And there you're going to see all of our mini classes. And while you're there, on our website, do sign up for our newsletter, because it really is the best way to get great information like this directly to your inbox. Thanks again for watching and as always, breathe easy. We'll see you next time.