The Nitty-Gritty of Good & Bad

HVAC Filtration with John Ellis

SPEAKERS
Kendra Seymour, John Ellis

JE

John Ellis
00:00
But I'm here to tell you that if you've got a good filter that is in a tight filter housing, and you've got a tight duct system, and it's maintained, the filters changing intervals are proper, you should never have to clean your ducts, your blower assembly, the evap coil ever.

KS

Kendra Seymour
00:33
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 nine. In this episode, you'll learn why not all HVAC filters are created equal. We'll start with a quick history of filtration. Explore how air moves through different types of filters, and share what to consider before upgrading yours. You'll also learn what MERV ratings are, how they're determined, and why the right filter is so important for protecting both your HVAC system and the air in your home. A bit about our guest as the owner of Dynamic Air Consulting John works with clients on complex indoor air quality issues, and provides in field coaching to HVAC professionals during the discovery, design, and implementation of IAQ solutions. With more than 40 years in the HVAC industry, John has spent time in several industry unions, including those for sheet metal workers, pipe fitters and the International Union of Operating Engineers. Before John started his consulting company, he owned and operated SoCal Air Dynamics, a performance based HVAC contracting company. Using a unique blend of building science and forensics and mechanical science, his company helped create clean, healthy indoor environments for clients with severe respiratory conditions and compromised immune systems. During his career, John has held numerous certifications, including building science, indoor air quality, EPA renovator, residential and commercial air balance, commercial systems performance, economizer specialist, Level one thermographer, and quality insulation installation. John has also been active in trade organizations such as National Comfort Institute, The Institute of Heating and Air Conditioning Industries and the Indoor Air Quality Association. Currently, John is the instructor for Dakin Amana Goodman, teaching the indoor air

quality principles workshop through the HVAC Learning Campus. He also serves as business development manager and field service trainer for the new flat rate, providing on site coaching to HVAC, plumbing, and electrical companies. Additionally, John is appointed product ambassador for Dust Free. John enjoys collaborating on industry articles and podcasts and presenting sessions at conferences, trade shows and industry events. Recently, John was voted one of the top 25 most influential HVACR instructors and trainers for 2024.

KS

Kendra Seymour

03:13

John, thank you so much for taking time out of your schedule to be here today. This, I have to be honest, is one of the conversations I was the most excited for because filtration is so important, and I feel like it's one of those areas that isn't as well understood as it should be, and you hear all sorts of different opinions and things floating around online and in Facebook groups, and they're not always accurate. So I'm so glad you're here to kind of set the record straight for us.

JE

John Ellis

03:43

Well, first of all, Kendra, thank you. It's my pleasure. I love this. And to your point, yeah, you know, we see a filter, and we don't really understand what all it took to get to having that filter, yeah. And so this is this presentation is a little technical, but I think the way I explain it, your audience will be able to grasp a lot of the concepts. We'll go into a little history and go through some things. So I'm excited to be here.

KS

Kendra Seymour

04:11

I love that. Let's take it away.

JE

John Ellis

04:14

All right. So this presentation, as you see right on the screen, is the science of filtration, and so in the book My House is Killing Me, Jeffrey May says that he believes that the HVAC industry is responsible for the health of the country, because all the air that we breathe in a building has to go through some kind of mechanical system at one time or another, and then we would hope that that mechanical system also has some kind of filter in place. And so that makes a lot of sense. And before we jump into the science of filtration, I want to lay a little groundwork if we can.

JE

John Ellis

05:00

So, I talked to HVAC contractors and environmentalists and remediation people and building science people all over the United States, and I often like to say that we can address a lot of indoor air quality issues using six key principles that most HVAC practitioners should already be doing in their everyday business. So we'll just go through these real quick. So thermal comfort, we are in the thermal comfort we are in the thermal comfort business. But what a lot of people fail to understand that people that are compromised can be very sensitive to thermal comfort, and it can exaggerate or exacerbate their symptoms and how they feel just with the thermal comfort in their surrounding environment. And then we have to talk about humidity, and depending on where you are in the country, that could be too much, or the lack thereof or a combination of both. So we really look at humidity through, you know, a deep understanding on what going on, what goes on in buildings with humidity, and then we talk about building pressures. And so this gets a little more into the building science side of things. But it's amazing how people who are compromised can be very sensitive to pressures within a building, but also when we look at building pressures, sometimes that's the driving force of where pollutants are coming in, if we're looking at infiltration rates, and if we look at if we have a slight negative pressure within a building or a structure in relationship to outside that can create undesirable results. So we really need to look at building pressures in many different ways, and that is, you know, mostly looking at infiltration, and then we have ventilation. And so more and more ventilation is becoming key. ASHRAE Standard 62.2 which is one of the standards we pay attention to it, is very commonplace now. It was a lot of municipality of states and different entities were slow to adapt, but that's becoming more and more prevalent in the built space. And then today will be our key focus of filtration, but then pollutant identification and source control is really big in what we do, because if we don't know what the pollutant is, we don't know how to go find it, or where it's coming from. And then not to go too deep, but I like to divide that into two categories. And we have synthetic pollutants, which are chemicals, VOCs and the like. And then we have organic which would be pollens and bacterias and spores and fungi and all that fun stuff. So that's just a little groundwork, but let's jump in.

JE

John Ellis
07:50
We're going to talk about filtration today. So here's a definition. So it's commonly known as the mechanical or physical operation, which is used to separate solids from liquids. And we have to understand that air is a liquid and it is fluid. So we interpose a medium through which only the liquid or the air can pass, removing all the solids. And when we say solids, that can mean, you know, dust and pollens and, you know, things get caught in the filter, and so that's just the basic definition of what filtration is. And of course, we're talking about air filtration in this episode. Of course, there's water filtration as well, and some of the principles hold true in that but with a little different dynamics, if you will. So a little history about filtration. Filters were originally installed in heating equipment simply to protect the equipment. The sole job of the filter was just to keep dust and particulates from entering the system and lessening the chance of mechanical failure. That was the sole purpose. And then later on, when they started adding air conditioning to the heating equipment, and I'm old enough to remember that we started putting evaporative coil on top of existing heating equipment. The sole purpose was to keep the dust out of the evaporator coil, because the evaporator coil would get wet, then the dust would stick to it, and that process would be repeated over and over again, and it would become quite clogged, and then we'd have a mechanical failure. So again, we were just focusing on protecting the equipment. And again, the primary purpose was just to offer protection for the mechanical systems. During the 60s and 70s, we had a huge influx of electrostatic filters, and I remember them as if it was yesterday, and they were making some big claims. But a lot of them you would order them to fit, or you would cut them to fit into a little spring loaded frame, and then they would slip into your existing heating or air conditioning or both systems. And

so those hit the market, and they were making some pretty big claims, greater than 90% efficiency. And so this is an interesting because a lot of filters, and even portable filters, and different, they make claims, we're 90% efficient, but they stop there, and the question Will has to be, well, 90% of what? Well we're doing 90% of birds, bees and bats, okay, that, well, that's but so they don't really, you know, go any further than that, 90% efficient, and it's like, Well, okay, so it's up to us and the consumer and and like HVAC professionals to go a little deeper and understand what exactly they mean by 90% efficiency. So we'll get into that as we go forward. And so the filter industry was born, and we're off to the races. And as you can see in this illustration, we get filters in every size, shape, color, V-Bank, HEPA, lots of MERV ratings, and we'll go into that in a minute. The top two on the top were the blue and yellow. Those are cut to shape, and we call those washable filters. And so we put them in and they do whatever they do, and then when it comes time to clean them, we take them out in the driveway, hose them off and smack them on the ground a couple times to get the water off and put them back inside the system and hope for the best. So and when we get into like clinical and hospitals and surgery centers, they got filters on the supply and the return and so they're built up, but that equipment can handle the resistance. So as you can see, we have a lot to choose from, and that's where it starts to get a little confusing for the consumer to know exactly which one should we choose for our equipment? And we'll, we'll talk about that a little later, too. So each time we go, it's a little teaser, because we're going to go deeper and deeper and deeper. So bear with me as we go.

JE

John Ellis

12:18

So what filters brought? So the pros, obviously, was better protection for the equipment, because that was the sole purpose originally, but then we started to see improved indoor air quality, and that's where we're at now, we want to see better indoor air quality, but we also want to protect the equipment, so it's got a dual purpose now, but the cons are the same now as they've always been, and that would be restriction to airflow. And once we start restricting airflow in our systems, all kinds of things can go wrong. Uh, during the energy crisis, homes were starting to get built tighter and tighter and tighter. So IAQ really started to get take root, because people were more interested in removing those particulates from the home for improved indoor air quality for the occupants. And that goes back to Jeffrey May's original quote that everything's gotta go through a mechanical system, so having a good filter in place goes a long way. And then with firm furnishings like wall to wall carpet and shag carpet. And if, if we remember Austin Powers and Shagadelic and you know, everyone saw, I get to go all over United States and go in homes everywhere. And every once in a while, I'll walk into a time capsule home and shag carpeting, and it's like, wow. And so the problem with that is it holds dust. And, you know, we've got lots of different carpetings and home furnishings now, but, but even that wallpaper, that's the stuff with, like, the felt on it, and that holds particulates as well. So we've come a long way. But I like to, I like to show this for nostalgic purposes, so we remember where we came from.

KS

Kendra Seymour

14:06

It reminds me of the bathrooms that have carpet in them. Have you ever seen those? And I was like, Wait, why did anyone think that was a good idea?

JE

John Ellis

14:14

Yeah, yes, yes on many, many levels. Yeah, I and I still see those from time to time, and it's like, okay, I'm thankful I'm not walking barefoot in this bathroom.

KS

Kendra Seymour

14:28

That's for sure.

JE

John Ellis

14:31

So along with wanting improved indoor air quality, you know, I all of us in the HVAC industry and others are cursed with wherever we go, the first thing we do is look at the air conditioning system, and we often see the black streaks, especially in restaurants, and then we're like, Well, why is it like that? And so we actually this in residential as well as. Well, why do we have black streets coming out of the registers? And then, of course, consumers thought, well, the HVAC system is making this happen, and so the contractor better make it stop. And so we do have some responsibility in this. And there's several reasons why this could be happening, and we'll talk about that as we go. Consumers expected filters, not only to protect the equipment, but we needed to keep the home clean and so and it's not to relinquish us from the task of having to do good housekeeping and dusting, and that looks different everywhere. But they just expected that, hey, I've got a I've got a filter in my HVAC system, I shouldn't have to dust. Well, there may be some truth to that, but for the most part, we still have to do our part as occupants in spaces. So this led to further evolution of HVAC related air quality products and services like duct cleaning started to gain traction, and that is a whole different conversation. And I personally believe that duct cleaning has its place, and it can improve indoor air quality if you have a a duct system that is just filthy, it needs to be clean. But the bigger question has to be, why? Why do I need duct clean? And so that leads into, well, maybe you've got substandard filtration. Maybe you've got a leaky duct system on the return air side. Maybe the house is leaky. And so those are three main areas that we need to look at when we look at a house that has streaks. And so it may be the filter is fine, but we've got duct leakage, and it's bringing dirt in, bypassing the filter. The house could be very leaky, and we talked about pressures and having a lot of infiltration. That's why we have dust everywhere. But I think that a duct cleaning is a maintenance service, because we are maintaining an air distribution system. But I'm here to tell you that if you've got a good filter that is in a tight filter housing, and you've got a tight duct system, and it's maintained. The filters, changing intervals are proper. You should never have to clean your ducts, your blower assembly, the evap coil ever. That's where we start to see some failures in the way our systems are built. Meanwhile, more and more and more filters started hitting the market, like that illustration I showed you, but the manufacturers were still using the same small, one inch little filter rack that really limits our ability to have good filter options. So then we started to create filter housings that fit outside of the the HVAC system, which gave us a lot more options to be able to do more robust filtration and be able to manage stuff like static pressure, resistance and airflow and stuff like that.

JE

John Ellis
18:20
So here's some filter types. So everybody's quite familiar with fiberglass. And then we have electrostatic. We've got pleated media. Which often are made out of fiberglass, but other kinds of materials as well. And then, and we'll talk about that as we go. Then we have extended pleated media, which means we're now getting into two inch, four inch and five inch extended pleated media in an external housing of the equipment. Then we have HEPA filtration. Now HEPA filtration is anything that does 95% filtration or more gets us in the HEPA realm, 98% and then we have electronic EAC air cleaners. I don't see a whole lot of electronic air cleaners around anymore. It's kind of antiquated technology. I do see them in people's homes still, and we'll talk about how those work as we move forward. So this is where a lot of people don't understand what all is involved in my filter. I have this filter how, how's it working?

JE

John Ellis
19:40
And so we've got five main filtration effects that we look at, and then the adsorption we're going to separate, and we'll talk about that separately, but we have straining, impingement, interception, electrostatic attraction. Now this is electrostatic, not electronic. So big difference, and diffusion. And then again, we'll talk about absorption as a separate thing. So the electronic air filter, which we talked about, kind of antiquated technology, has an electronic element that gets energized. And so then we have the air that goes through a pre filter. And there's two types that would either trap those parts of particles on the element, or some of them would actually zap them, and they sound like a bug zapper and, and it's actually breaking those particles down from larger particles to smaller particles. The problem with those is that when the system turns off and that electronic element is de energized, there's nothing holding those particulates anymore. And then upon initial startup, and you get that blast of air, a lot of that stuff will kick loose, until we can start having more attraction, and so we'd have to really maintain and clean those quite often, more often than what the manufacturers would suggest. So in essence, they're almost self cleaning every time the system deentergizes and turns back on. That's a little filter humor there. So let's, let's go through these, these five different processes, if you will.

JE

John Ellis
21:31
So straining actually just captures large particulates because they're just too big to fit between the filter fibers in the filter. This is where we get into the birds, bees and bats that they just can't fit, so they get trapped and so, and that's important. I mean, we we want to be able to filter many different size ranges of particulates as they enter through the filter. Impingement, so larger particles, but we're going to get smaller and smaller as we go. They can't follow the airstream, and so they will collide with the fibers and become attached, depending on what those fibers are made of. And so each time we get a little smaller, in the in the in the particulates, we're going to see where different filter methods really come into play, and how important it is to maybe incorporate all of them, or at least most of them. And so, yeah, they can't follow the airflow, and they collide with the fibers. So interception. Now we're going to get smaller they're captured when the air stream becomes comes within a half a particle diameter from the fiber. So now we're getting the smaller particulates, and they are captured when the particulate comes in within a half of the

diameter of the actual particle. So if this were a fiber, so we're talking at a microscopic level, and a particulate is heading towards it, because at a macro level, because this resistance, the particle will veer away from because if we look at there, there is a positive and a negative pressure, but there's pressure backup, that's what we call static pressure and resistance. At a micro level, will cause that really light particle to veer away and then collide with a different fiber. And so there's other things that come into play. So we look at when air changes direction and different things face velocity speeds up and slows down. It becomes very chaotic as it enters a filter. And that works to our benefit, because if a smaller filter, I mean a smaller particulate, it would head into a filter media it's hard pressed to get through. But this chaos works in our, to our benefit.

JE

John Ellis
24:07
And so electrostatic attraction has to do with what the filter media is made of. And so when we look at synthetic materials, like a poly, polypropylene and or a synthetic material. And the best illustration I have is, if you take a balloon and you rub it on your arm and it'll stick to the wall. That's electrostatic attraction. So as the air goes across these synthetic materials, they naturally will get a electrostatic attraction, just like rubbing a balloon on your arm, and then the particles will stick to them as they go by. And then finally, diffusion. So very, very small particles, usually in the PM 2.5 or ultra fine and smaller, are bounced around with the air molecules because they're so light and so influenced by the air and the chaos that's going on, the particles will collide with the fibers and then become attached. And so a lot of this has to do too with the thickness of a filter. They can't get a one inch filter to be able to incorporate all these methods, because there's just not enough media mass there to create these, these five different methods.

JE

John Ellis
25:44
And so now that we've gone through that, we're going to switch gears and we're going to talk about adsorption. And this is the use of activated carbon. Okay, so let's start with defining adsorption, because it's so easy to just say adsorption in here, absorption, or vice versa. But adsorption is the ability for a substrate like activated carbon to hold and attach pollutants to the outside of that material. Where absorption is the ability for a substrate to be able to absorb into it the pollutants. And so that would be like a sponge absorbs the water, because the water is actually entering into the material. And so the it's important that when we talk about activated carbon, truly activated carbon, that this is adsorption. You're going to hear me say truly activated carbon, because there is a misconception in the marketplace, when people see a carbon filter in either the big box stores or even in our supply houses, that it is not truly activated carbon, most of the time. Now, it's carbon by default. We're all carbon by default, if you wanted to look at it that way. But most impregnated filters use granulated charcoal, which is carbon, and it's such a small amount, because we still need to get air to go through that filter that any kind of adsorption properties to that carbon are very short lived depending on time of use and humidity really beats up carbon and it's granulated, so there's not a whole lot of mass there, if you want to look at each granule when we impregnate a filter. So that has been a big misconception in our marketplace. And so when we talk about activated carbon, it activated carbon can be granular, but most of the time we're talking about pellets. And the best description I have of a pellet would be almost like rabbit feed a little pellets you feed like that, except it would be made out of activated carbon.

JE

John Ellis
28:19
So let's talk about how it's made. Each pound of activated carbon can adsorb, on average, a third of its weight in pollutant compounds removing them from the air. Step one is the carbonization. First, they take carbon and they compress it into the pellets. Then the pellets are placed into a tank completely devoid of oxygen and subjected to extreme heat of 600 to 900 degrees Celsius, which would be about 1200 degrees Fahrenheit. And then it's removed from the tank, and it's allowed to cool down. Then it's placed in another, in another, a different table of the same tank. But then it's exposed to chemicals such as argon or nitrogen. Those are those are both inert gasses. We typically use argon because it's a little less expensive and we get the same reaction than we do from nitrogen, but that allows us to really eliminate any kind of oxidation. We see oxidation in the world around us, on our cars, and, you know, we go out to our air conditioning units and they've got this white film on it, and that's, that's oxidation, and that's because of the exposure to oxygen and other compounds as well. But the nitrogen and argon completely allow no oxidation. It's placed back in that tank devoid of oxygen, with the argon heated up to 900 to 1200 degrees Celsius, which is about 600 to 1600 degrees Fahrenheit, it allows us to burn off any impurities that could be there. The argon eliminates any kind of oxidation as the carbon molecules open up and expand because of the heat, as they cool down, they start to lock together, and causing that carbon pellet to now be very receptive to adsorption, and that's how activated carbon is made.

KS

Kendra Seymour
30:44
So this is so important, because I think whether we're talking, obviously it's the HVAC mini class series, but filters are found in standalone units and things like that. And one of the things we talk about a lot is understanding what each of these components can do. So you're doing a great job. So people, a lot of people are familiar with HEPA filtration or MERV filters, and they think about it in terms of particles, right? They want to stop the dander. They want to stop the mold spore and the fungal fragments. When we talk about the activated carbon, is that more for gasses, VOCs, or does it also play a role in stopping particles?

JE

John Ellis
31:26
Typically, you would have a pre filter to do the heavy lifting of removing particulates, because we don't. We want the activated carbon to do it the job it's intended to do. And so when we talk about formaldehyde in the home. Really, activated carbon is the only thing that can remove that from the space. When we talk about gasses and TVOCS, activated carbon really, you know, of course, we want to always address the source. Can we find the source? Can we can we address the source? Can we mitigate the source? But if we're have to remove carbon, is the only way to do that. You will start to hear more and more about ground level ozone is starting to rear its ugly head again. In the 60s, we had a problem with ground level ozone, we were getting up over that 50 parts per billion ambient outdoors. Then we really started to look at how we were doing industry, and really the invention of catalytic converters in our vehicles really quail that and started to knock down those kinds of emissions. But recently, ground level ozone has started to rise again. And now it happens naturally, but it also happens with what we're doing and depletion of the ozone level and different things. But it happens, you know, the sunlight. Even the sunlight and air going across power

lines, and sometimes you hear that buzz, well, that's actually creating ozone. And so those things are starting to to show up, and the levels are climbing again. We're getting above 50. And so ozone is kind of a wild card, and it reacts with things so different. It's it's radical. It's got that extra atom. And sometimes that atom will detach and it just, it interacts with so many different things in in a very radical way. And so again, one of the only ways, besides identifying the source to remove ground level ozone is through activated carbon. So it really does a great job. Now there's a lot of discussion on how much. So there are portable air purifiers that have an impregnated carbon filter that do a little bit for a very short amount of time, but there are better ones out there that have five pounds of activated pellets. There's others that have 10 to 15 pounds. And so that's that's kind of the magic number, between five and 15 pounds, that's a lot, and it's able to do a lot of absorption, and of course, that that's a lot of media for it to travel through. So the systems, especially in portables, are designed to handle that resistance, and they just do a fantastic job. So activated carbon is great, but we have to understand, you know, how much there is, and is it granular? Is impregnated, and you know, is it really going to do the job that we think it's going to do? And so that's where consumer awareness, a little bit of homework Come in. Did I answer your question?

KS

Kendra Seymour
34:52
You did absolutely. Thank you.

JE

John Ellis
34:54
Okay, so let's go through. So most filters on the market, especially the one inch, two inch, they only use one or two of these filtration effects. When we get into some of the extended pleated media, they're able to incorporate maybe a third one. There's not a whole lot of inventory out there that does all five of those methods. And so, again, know what you're buying? Do a little research. Look, look into, you know, the manufacturers of extended performance data will, will tell you that sometimes you gotta dig. It's not really, you know, on the surface, because they think people don't understand, but we do.

JE

John Ellis
35:45
So we're going to talk about you can't just throw a filter in place without understanding the cause and effect. So filters are designed to move in a certain amount of air, cubic feet per minute, or CFM, right at a certain velocity, which would be feet per m, feet per minute, or FBM, I tried to say those two in one. Through a certain size, or what we call net free area, in square feet. With a certain amount of resistance to the flowing air through the filter, we call that pressure drop. So those are the four main pressure points, or measure points, that we have to be concerned with when designing a filter into our system. So C don't we're going to get a little geeky here. So C equals CFM, V equals velocity, A equals the net free area in square feet. So if we have two of these measurements, we can get the third measurement. So first of all, to obtain the net free area, we take the height times width and divided by 144 and so we have to remember, too that filters have like a cardboard frame. We need to measure the inside of the frame and not the outside of the frame, to get an accurate number. So if we were to take velocity and times it by area, that will equal the cubic feet per minute that that filter can handle. If we've got cubic feet per minute and we

divide it by the net free area that will give us the velocity that that filter can handle. So we don't need to be able to physically measure all three, but we need to get some kind of measurements.

JE

John Ellis
37:39
Filters are rated for a one to two inch filter at 300 feet per minute. And then a larger filter, larger than two so extended pleated four and five inch filters are able to handle 600 feet per minute. So what this means, if we have a single filter at the furnace or the air handler, we have to make sure that that filter is able to handle up to 600 feet per minute. Most of our residential equipment does 492 feet per minute. And so we have to make sure that that filter can handle that much velocity at right at that unit, and I see one inch filters at air handlers all the time, and it they're just not meant to be there. Now if we've got, let's say, a return air filter grill in every room, each one of those can be because of one inch because they're only handling 300 feet per minute. So we got 600 feet per minute in a trunk, and then we got 300 in our branches. So this is important to know again, that we have to design a filter into the system. We can't just willy nilly, just slide something in and hope for the best, but it happens all the time.

JE

John Ellis
38:54
So how can you tell if your filter is large enough to allow the proper amount of airflow. So this is from the National Comfort Institute. Their whole world is airflow and static resistance. But here's a quick formula to tell if your filter can handle the CFM at 300 or 600 feet per minute. So height times width times two will give you the acceptable CFM for both a one or two inch filter. And height times width times four will give you the acceptable CFM at 400, 600 feet per minute. So if you go up to a filter, pull it out, do this calculation real quick and say, hey, you know what? Based on this calculation, it it can't handle it, or it can, or do I need more than one filter in place. So this is for the HVAC people in the group.

JE

John Ellis
39:53
So this is actually a live illustration. So this is a Goodman furnace, and what we did, and it's a 3 ton system, so it's able to deliver 1200 cfm. And then we have our static pressure at the bottom in inches of water column. And we're going to go ahead and introduce some filters and take some some measurements. So with no filter in it whatsoever, we're able to move 1200 cfm right on the dot. And so we're going to introduce a one inch MERV four, spun glass. It's static resistance is .22. We've already lost 100 cfm. Now it's only a MERV four, which is better than a MERV zero. And we're going to talk, we're going to talk about MERV in a minute. But I want you to understand this is made out of spun glass. Remember, I talked about some of the things that filters are made out of.

JE

John Ellis

40:51

So let's go ahead and introduce another one. Here is a four inch. So this is a one inch. Here's a four inch. MERV seven. It too has a static resistance of .22, and we're only lost 100 cfm. We went up three percentage points in our MERV rating, but it's also four inches thick. Now this is made out of polyester. Polyester has a pretty nice electrostatic attraction because of what it's made of. And as that air goes across it, we get that rubbing of the balloon on the arm and sticking to the wall effect. So let's move on.

JE

John Ellis

41:34

We're going to go to everybody's favorite, the MERV, the one inch MERV. I can't see what it is. I think it's a MERV 11, polyester. It's static resistance is .58. Off the charts. It now brought our CFM down to 950. This is the one you get at the big box store, they call it the allergy buster. It's a 3M and I will say this, I have tested these for particulate removal, they are fantastic. But they are giant slayers, and they will slay your system if they're not designed in properly, so, real quick. So, we have to watch out. And this is what I see in many, many homeowners homes. They take their one inch mer for spun glass out, they slide the allergy buster in, and then they can't understand why their system isn't work. And it's always worked great before, but we just, we just blew all the statistics, you know, out the window when it comes to system performance.

KS

Kendra Seymour

42:48

I'm really glad you mentioned that, because that's a takeaway. A lot of times, listeners are like, Oh, I know that filter is better. It's going to trap more, I'm just going to stick it in. You should not be upgrading necessarily filter capacity or capabilities, I should say, without understanding what your system is designed to handle. So I think that's a really important reminder for people, and you can work with your HVAC company to figure out what, what is an appropriate the highest rated filter, perhaps, that your system can handle.

JE

John Ellis

43:20

Right and that's just sliding on in and calling it a day. Or what do we do to design in a new filtration system? Yeah, very important. So this is a four inch, also a MERV 11, and it's static resistance is .21. Now we're in a decent operating range, but notice it's made out of poly olefin, a different material. And so one caveat about these different materials is the polyolefin will react negatively to UV light. So if you have a UV light in your system, and I've seen them in the darndest places, and that can be a discussion for a different day. But they will deteriorate that material, and they polyester holds up a little better. And so understanding, again, some of the other parameters when you're putting a filter in and what it's made out of. But like the polyester, the polyolefin, being a synthetic material, does have a pretty decent electrostatic attraction to it. So the takeaway we have to understand is you can't just throw a filter in place without understanding how it's what its operating parameters are, and do we need to design it in to the system?

Because at the end of the day, you need to choose your filters wisely, or else it could cost you big bucks in the long term, when you start to have catastrophic failures.

JE

John Ellis
45:03
And so what are those catastrophic failures? So high limit on heat. So, meaning that we we've compromised the airflow enough for in a heating mode, this is gas heat, that that heat exchange is going to get way too hot and it's going to shut down. Also, if we let it continue, and it's, you know, operating and shutting down, operating, that we're going to put a lot of stress on that heat exchanger. It's not meant to handle that grade of heat, and we could compromise the heat exchanger. And so then also the motors in a standard HVAC system depend on that air going across itself to keep it cool and running. Anytime we've got components that are running hot, that equals energy and it also equals a shorter lifespan. And then in cooling, the same thing holds true for the motor, but also we could be sending liquid back to the compressor, because we need that airflow for complete refrigeration cycle. If we don't have a complete refrigeration cycle, now we are not doing proper, latent, sensible and now our humidity could get out of control. Our comfort can get way out of control. So there's a lot of cause and effect just simply having the wrong filter in place.

JE

John Ellis
46:27
So solutions for this. So we're, we were, we've been talking about static resistance and how certain filters have this kind of resistance and and we saw the allergy buster had .58 inches of water column resistance. Well, our, most residential equipment that we have at our disposal today only have .5 inches of water column. They only have a half inch. And so I like to describe this, so that we're going to get a little HVAC geeky again. So we're designing a system. Let's say we're designing it from the beginning, or maybe it's just a change out, or maybe we need to add in a filter. But we know we've only got a half inch of static available as a budget, and I like to say we got five bucks. So we have $5 in our static pressure budget to go shopping. And so we're building our system. So the first thing we do, or we're looking at, is this existing system. We know that our air conditioning component, our evap coil, only comes in at about a .2. So there's two bucks out of our five bucks. We got three bucks left. And so now we look at a filter that can come in at a .2, and and we figured that that's reasonable enough, so we just spent two more bucks. So we got $1 left to go shopping. And so what's that left for? And that's our duct system. So we have the equipment. It's going to do what it's going to do. Now we only have $1 left to go shopping for our duct system. But wait, there's a lot more to that. Because when we talk about our design criteria, we have the duct system, but part of that duct system would be our termination points, grilles and registers, and they bite into that budget too. So we may only have 75 cents to go shopping for a duct system. So knowing those numbers and being able to you could go up to an existing system and and say, Hey, I got five bucks and and you start eating away at your budget. And you know, my goodness, the allergy buster ate my whole budget now I can't go shopping for anything. I gotta, I gotta borrow money, and where you going to borrow that from? And so we start to have shortcomings in other areas, and it's just doesn't work out well. So that's a basic explanation on a static pressure budget. And then what effect does the filter have on that budget?

JE

John Ellis

49:04

So let's talk about MERV ratings. Because we hear the term thrown around a lot, and it's interesting 3M I think they're actually giving MERV ratings now. They didn't used to they used to give their filters a star rating, and certain felt, Oh, this is a five star, this was a three star. And then they very quietly, you know, because they were trying to buck the system, they very quietly started adding MERV ratings, because that's the standard, which we all got to follow. So they, they got on board. So filter manufacturers test their products using what we call the average arrestance test, or the dust spot efficiency test, most of the time, both. So what this means is they have a filter, and we're in the lab, and they have a certain amount of particulate matter in different size ranges, they're going to release it, it's going to go through the filter, and they're going to recollect it on the other side, and that's going to give them numbers or data for both of these criterias here, and then that's going to allow them to give their filters a rating. And it's based on the amount of dust that it removes, but it also measures airflow and static resistance too, because that's all part of the equation. This efficiency test was given a number between one and 16, and it's called the MERV, or minimum efficiency reporting value. This standard is set, was set to us by what we call ASHRAE Standard, 52.2. It's like, hey, we need to have a standard that everybody can adhere to, so we're all measuring things the same, and it's apples for apples, and we're able to really understand and be fair across the board. And so this is usually it's least efficient condition and brand new. Now they also have, they can take the data, they can extrapolate the numbers, and be able to give us life expectancy, which we call a filter loading curve. But that is so, so subjective, because every environment is going to be different, and so, but, but at least it's something. And so there. And then they try to say, Oh, well, you know, in normal conditions, well, what's normal conditions? Tell me what that is. And so, very, very subjective, but this is a good way that we're able to at least look at a filter and say, hey, you know what this meets my criteria and what I need to get out of a filter. So again, ASHRAE 52.2 and so they measure five sizes of particulates going from large to small, and it's also used in air cleaning devices and filtration, and so it is the standard on which we adhere to in the HVAC industry.

JE

John Ellis

52:14

All right, I've already said this. I do that once a while. I get ahead of me because I already know what the next slide is. Size matters, and we're going to talk about particulate sizes. So PM 2.5 is where a lot of the attention is being given right now. And these are smaller than 0.3 microns in size, that when inhaled all kinds of problems can can happen. And so we have, PM, 2.5 and then we've got ultra fines that go smaller than this. And obviously the health ramifications are pretty staggering when you look at it. PM, 2.5 and smaller can be absorbed. There's the one with the B into the bloodstream through the lungs and enter into the system. And so this is, this is a neat illustration from a company called Particles Plus. And I want you to understand also that we measure particulates in two different ways. This measurement we see here is in micrograms, and it is a weight by concentration. The other way we measure it is in a raw count, where we're actually counting particulates in each size range. I prefer a raw count. It's easier to understand and it's easier to communicate with clients and homeowners. But they're both both used in the industry today. And so as we're looking at the first one, we're looking at PM, 10 micrograms, which is fairly large, and so it's just we're just starting to inhale it. It can be depending on what now we're not speciating, but depending on what those particulates are, can also, you know, contribute to the health effects as well. But it's starting to enter the system and into our lungs, and then we get 2.5 micrograms, which would be like the 0.3 microns. You can see that it's really starting to get into the lung tissue itself. And then we when we get into the ultra fines, you see it gets into the lungs, it gets into the organs, it gets into the circulatory system and into muscle tissue, and everything else, and that's when things really start to go sideways. There's all kinds of studies out there now about the effects of air pollution and both ambient, outdoor and indoor, and the effects also of TVOCS and chemicals getting in the same way, and then synthetic and organics. There's been a lot of discussion about early childhood asthma as of effect of being exposed to PM. And there's also been some studies linked to ADHD in children, because it does affect cognitive as well. And then when we talk about chemicals, and we're talking about even something as simple as carbon dioxide, which depletes oxygen, which is imperative for us and our cognitive health, and we use that as a proxy for our ventilation, that that there's staggering effects on our children in their developmental stages, and what effects those have, so that that also is a discussion for a different day.

KS

Kendra Seymour
55:53
Yeah, no, but,

JE

John Ellis
55:56
But it's all important. So this is, and this, this stuff is these charts are available through your AQMD, Air Resources Board, the EPA, and you can look these up specific to whatever area you're in. But this is giving some, some rough guidelines on what's acceptable. Again, this is very subjective, because anybody that's compromised in any way, shape or form, obviously these levels wouldn't adhere to them or pertain to them, but, but this is some standards that they give and so they look at and this is ambient, outdoor and so what happens when these pollutants get indoors, they have nowhere to go. Concentrations build up, and then we're exposed to them in greater concentrations. But we this is accessible in many, many different platforms out there.

JE

John Ellis
57:00
Let's get into we talked about these filtration methods. We talked about static resistance and all that stuff. But let's talk about how we get to like, hey, I want to design a filter, to actually having a filter. And so we have some criteria that we we have in mind. Like we wanted to, we wanted to, we want to do merge 16. We want to be able to remove this kind of, these kind of particulates. We wanted to have this kind of resistance. And so where do we start? Well, we take all that information and we run it through what's called Computational Fluid Dynamics, and this software is allows us to kind of predict where we're going to get through as we try to fulfill all those obligations for design criteria. So once we have our technical data, so, net free area, the depth, the types of filter media that we want to use, the filtration methods that we want to accomplish. All that information is put into a software. And the software, it's a modeling software, it starts to run the numbers. And so in this particular picture here, we're looking at velocity in feet per minute. This is a V-Bank style filter, and you can see the color coding would be the resistance of velocity. And so blue would be, hey, we're not achieving any velocity. And that would make sense in this illustration

because we have the bulkheads which hold the filters in place. Obviously, that's a solid piece of metal or whatever that we air is not going to go through that. But we can show the air entering and leaving, the filter media itself. And as we as we enter the filter media and it leaves. You can see that we regain our velocity. So this is when I was talking about how air is so chaotic. Air is fluid. Air has no shape of its own. It takes the shape of the container it's in. And a duct system is a container. This filter housing is a container. Our house, you get in the car and close the door, you know this, this bottle of water is a container, and it's half fluid and half air. Our lungs are containers. So this is all goes into effect. And then we look at what air does when it's in a duct system, and it starts to, we have the fan, which is driving the airflow, and then we have our velocities and all and we have the resistance, and we have the the static resistance for the amount of duct work it's going through. But we have something called vena contracta, and that is when air is going through, let's say, a round duct, and that's the shape. And then we change directions, and it goes to a long and square, rectangular or into a square filter housing. And as we go through and change corners, the outside is going to have greater velocity than the inside of a radius, and then it changes. We get greater phase velocity. And then once the air changes direction and tries to straighten out again, all those, all those numbers start to taper out and even out and equalize. But that all goes into what happens just before the air enters into a filter housing. Is it coming straight through? Are we hitting a hard 90? Is there several of them? So this is all part of the the predictive or the modeling as we look at the computational fluid dynamics. So it's really quite fascinating. And so this particular one is looking at static resistance in inches of water column, and zero being the least resistance. And then the yellow here and the green are showing more. We're not showing any red. So and so for this, this was for the for this modeling, we're just saying that the filter is just has the airflow going in and leaving. There's no bends or anything crazy going on. But you can see that the inches of water column are a little restrictive as they enter into that filter, because we do have some resistance, but as they leave that filter, the air starts to equalize the pressures and leave the filter. So this is, this is pretty, pretty neat. So as we're looking at the results of the computational fluid dynamics, and they're not making sense, we can make tweaks in the input data, and till the final results start to look like, Okay, I think, based on this modeling, I think we're finally there. Now we can design a filter, and so we have to choose our filter media. I mean, we already had an idea, but we need somebody to either manufacture that media with our criteria involved, or find something that's already there. We need to find a company that can pleat it for us. Maybe, maybe we're a company that can pleat it ourselves. But all this goes in to like, okay, let's make a filter, and then we have to make the housing, too, if that's the what we're trying to accomplish. Some some companies just want to make that filter, and they'll put it into a different manufacturer's housing, and that's okay too, but we have to know that. And so we get the filter media, we get the housing, it's built, and then we have to go to the lab, and we have to do live measurements. And so this process is long and involved many, many trips to the lab, and we finally have a product with with performance data and loading and all the stuff, and we're ready to go to the market. And so that's a lot that goes into a filter. When you hold up a filter like all that went into that at one time or another. Yeah, yeah. So it's pretty fascinating.

JE

John Ellis
1:03:36
So let's we've been talking about designing filters. And so this is going to be just a little plug, if you will. I've been working with Dust Free. Well, it's been, it's been a year now, for two years with the engineers doing all of this that I just described, and we finally came out. It was a real special product with our own filtration system. So if I may, I'd like to share this with your audience. So this is the Dust Free 16. This is a

MERV 16 filtration system. Not only did we go to ASHRAE 52 and get our credentials for the filters themselves. That wasn't enough. We got a MERV 16, 52.2 credential for the whole system. So we've got dual credentials. Not many companies do that, but we thought if we're going to market, we want to be the best in class. We got very low static resistance. We've got a very robust electrostatic attraction. We use all five filtration methods in our filter media. We buy our filter media from a company in Europe because they were the best one for the job. We bring the filter media in. And then we have a text, a company in Texas that pleats it and puts it together in in the filters that you see there. Um, our electrostatic attraction, our front loading is phenomenal, but as the particulates permeate through the filters, that electrostatic holds up. Our MERV 16 rating holds for the entire life of the filters. Some of our competitors lose their MERV 16 in about three months, and they drop to a 14. We get three years out of a filter change, and we never lose 97% filtration.

JE

John Ellis
1:05:47
That's our published data. I got them in the field, and guys are measuring 100% filtration in the field. So it's very user friendly. It's on the market. I am so excited. They're selling. And, yeah, it was a, I had some very tall standards for the engineers when we went into this. And boy, did they delivered. And part of the fun thing about this, it comes knocked down in two boxes and assembles in about 15 minutes. So very user friendly. So that's the Dust Free 16. Very excited. And thank you for allowing me to share it. And thank you,

KS

Kendra Seymour
1:06:31
John, this was incredible. I mean, there's so much power to the filter. The thing that people, I'm afraid to say, some people, I don't even know if they realize they're supposed to change their filter in their HVAC systems. Part of the reason we're doing this series for all the components, and there's, there's so much great information here that I feel like I am definitely an empowered consumer now when I start to look into this for my home. So thank you. So I'm wondering if you couldn't clear up a question that I see going around all of the time in the Facebook groups and online, and it's and you you answered it, but I'm going to ask it to you kind of directly in the way that I see it phrased. People will say that a HEPA filter, or really any filter, that it could be less than HEPA filtration, cannot capture particles smaller than point three microns, true or false?

JE

John Ellis
1:07:35
That's a great question. And so you can have, you can have a higher rated filter, like a MERV 16 filter, that still does not use all five filtration methods. And so I think that a MERV 16 filter, which is just below HEPA, can capture those particulates at that size range. The one caveat is we really depend on a very robust electrostatic attraction in that filter media. We also, if we look at what how the filter media was originally woven, and we use micro fiber technology. Meaning all the threads in that filter aren't going to be the size of, let's say, sewing thread. They're going to be many different size, and they're going to be woven in such a way that we can recreate those five methods. So and that that is, that's a subjective question, because not all filters are created equal, as as I talked about in this, in this presentation, But yes, they can, and they can

capture 2PM, 2.5 and some of the ultra fines. Now also, some filters will do a little better in that size range once they have some loading. But back to the DF 16, we do that work the minute that that air starts going through that filtration system.

KS

Kendra Seymour
1:09:24
And I think, and I think, you know, if you're coming at it from the HEPA terminology, when people are talking about that and standalone units and things like that, the concern is because of how it's rated that point three microns, oh, that means it doesn't capture particles smaller than that. And it does, and we don't, you know, we have an interview with Carl Grimes for those interested. We talked about these penetrating particle size and why that was chosen, and stuff. But I want people to understand that, while, no filter can capture 100% of everything. They can do a really good job at capturing these fine and ultra fine particles to improve our air so I really appreciate that.

JE

John Ellis
1:10:08
That's a great point. And here's one thing that we have to understand, identifying the source and really getting a handle on that will allow our filtration, will allow our portable units to do the job they they need to do. The one thing about all these units is if that particulate is in the air and your filter is going to do whatever job it's going to do, we are still in the room with those particulates. So before that filter gets to do its job. We are there, and we're still going to breathe them. Now, we like to get to a point where our our ambient air, our levels are way down, and we can be in that room, but that's a heavy lift, and it's not just a filter that's going to do that.

KS

Kendra Seymour
1:10:56
Yeah, yeah, and I love that, but that's why this is part of a multi layered approach, right? It's it's filtration, it's ventilation, it's source removal and control and all of these things that come together to make a healthy indoor environment. Thank you so much, John. I do want to ask if people had follow up questions or wanted to learn more or get into contact with you, is there a website they can go to? Is there any contact information you want to leave us with, because we'll link to it in the show notes.

JE

John Ellis
1:11:22
Yeah, you know, as you know from my bio, I used to own a HVAC company, and ever since I got into consulting, I never created a new website. Just wasn't the way I wanted to go. But if you Google John Ellis and IAQ, I got a ton of stuff out there on YouTube, and if you want to put in the show notes, people think I'm crazy, but my phone number is 505-652-8119. I give out My number all the time. I haven't had one crank call yet, and I get the best phone calls.

KS

Kendra Seymour
1:12:06
I love that, John. Thank you so much. You're a bit of a legend in the industry, and there are, I can attest a ton. If you just put in John's name, you're going to see a ton of information other interviews. And you speak all the time at conferences and industry, and it's, it's amazing everything that you're doing. So thank you for your time, sir. I really appreciate it.

JE

John Ellis
1:12:26
My pleasure.

KS

Kendra Seymour
1:12:27
And for everyone else listening, do me a favor, if you found this interesting, I want you to do two things, hit like and follow on our YouTube, if that's how you're watching it, also head on over to our social media and hit like and follow, because we do a lot of companion pieces, that piggyback off each of these interviews in our mini class series. And because I want you to never miss an episode of this as it drops head on over to ChangeTheAirFoundation.org, and sign up for our newsletter, because we send great interviews and downloads and other resources just like this directly to your inbox. And if you want a shortcut to getting to the mini class series, because you want to binge them all this weekend, which I hope you do, you can find that under our resource tab and just click mini classes. Thank you so much everyone for listening, and I hope you come back for our next episode, because the fun continues. Thanks so much. See you next time.