

Notes on Dust Collection

Are you not sure if you've got a dust control problem? Dust off a small space in the workshop. Do some work and if you've got dust on the spot you cleaned, you've got not just a dust problem, but a health problem waiting to happen; and, if you figure the commercial offerings are going to protect your health, read on...

I've based this article on information from several standards organizations and manufacturers that you'll see noted below. The most efficient, common, and suitable, air filters that I can find are for home furnaces. That's why I started using them. **However, I've found out that the standards noted below are not policed nor verified. That means that any filters that you and I might have access to might be useless. There are few manufacturer's that allow their filters to be independently tested.**

Note that there are two dangers to dust; pollution poisoning and spontaneous combustion. I've done Mythbuster-like experiments with dust and believe me, I couldn't be far enough away from the fireball. For those who do not have exposure to North American TV, Mythbusters is a TV program where they create explosions for fun. For the poison part, read on...

Please understand the importance of what I present below but make sure you've done your homework and research before spending hard-earned monies. Also demand of your suppliers that your filter's ratings mean something. My objective is to make you aware of the problem and get your little grey cells hard at work. That said, we must do something sooooo, here's hoping what's below is better than nothing!

Please note: the Bill Pentz website is a must read for everyone! Bill is living with the effects of dust damage and has undertaken to educate himself, and generously, us, with what really happens when you don't take dust control seriously. It is one of the few sites based on research and not marketing.

<http://www.billpentz.com/woodworking/cyclone/index.cfm>

Please seek out and familiarize yourself with his "Wood Toxicity Table" (<http://billpentz.com/woodworking/cyclone/WoodToxicityTable.cfm>) I use a lot of sugar maple so I am now aware that possible side effects will include pneumonia and respiratory problems. His table points out that maple is poisonous. Oops, that's a serious word.

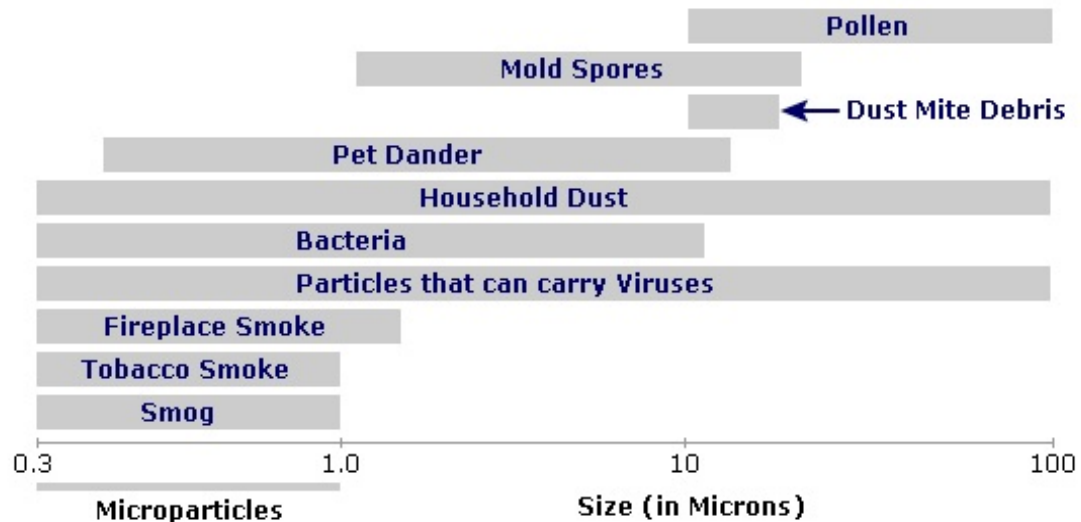
I have read parts of his site and determined that if you don't take dust collection and air filtering seriously, wear a hazardous materials face mask. It's that serious! I'm now retired and living in a place with clean air and clean water but my shop was giving me respiratory problems. In spite of the pristine natural environment I live in, I'm still suffering with the effects of dust. And, don't think you're not affected if you're young. You are investing in your future!

You must also realize that in the days of hand tools, little dust was created and was not an issue. I use scrapers and hand planes and I generate a lot of shavings but I don't generate a lot of dust. But, turn on my table saw for a moment and the workshop is filled with fine dust particles scraped off the board and flung into the air, millions of times per second. Try a sander for a few minutes and look at the clouds of dust in your shop. Modern machines create so much dust as to absolutely require control. My objective is to try to provide a frugal view of the problem. But, you'll realize that with Bill's research, it does have to be taken seriously.

To start, here's a list of common pollutants and the means to measure them.

A Micron (μm) is one millionth of a meter or approximately 1/25,000 of an inch. For comparison, a human hair is about 70 microns (μm) thick. Typically, air filters are rated by the size of the particles they can remove. Most decent furnace filters can easily remove particles larger than $10\mu\text{m}$ in size, but the best filters are able to remove particles smaller than $0.3\mu\text{m}$.

Typical Household Contaminant Sizes



<http://lib.store.yahoo.net/lib/fridgefilters/household-contaminant-size-chart-5.gif>

You've determined that you have a problem. You're tired of being the guinea pig and want to really find out what's going on. So, here's where things get really complicated. There are two forms of pollution, bacterial and dust. The two are usually present at the same time but there are methods of measuring that will separate them. One of the forum members offered up the Dylos Air Quality Monitor as part of his solution. He measured his workshop after using a dual drum sander or router and got a reading of 6,500 (parts per million?) He ran his shop built air filter and after 5 hours the Dylos gave him a reading of 65.

If you have asthma, allergies or just plain chest congestion, the air quality monitor is definitely the starting point. If you chose to go this route, please keep me apprised of your experience and progress. It will serve to update this article for everyone.

There are two parts to dust collection, the dust collector and the air filter.

The dust collector:

This is a chain of parts that moves dust-laden air from a tool to a particle removing method and, hopefully, clean air back into the room. This, normally, starts as a hose connected to the tool, i.e. the table saw. This hose gets connected to a fan that sucks dust laden air from the tool and blows it into a filter/collector of some sort.

1. One type of "dust collection" consists of a bag (or bags) on the end of a fan or blower. The blower moves the air from the tool and pushes it into a filtering method. Some commercial and hobby dust collection systems use cotton bags to provide the filtering. This one is supposed to filter 1596 cubic feet per minute and supposed to filter particles down to $1\mu\text{m}$ but they don't specify how efficient it is ($??\% \geq 1\mu\text{m}?$). That leaves all of the dangerous stuff ($0.3\mu\text{m}$ to $1.0\mu\text{m}$) blowing around your shop from the tool and the dust collector. But, on a French language site, out of sight of the American marketplace, it states "Filtration: $35\mu\text{m}$ ".

(<http://www.outillage2000.com/Machines-bois-Aspirateurs-Aspirateur-copeaux-FOX-p-2187.html?osCsid=50f72e684937ce43bc5ed18f36cd0aff>) This example is BusyBee's.



<http://www.busybeetools.com/products/DUST-COLLECTOR-2HP-1596-CFM-1-MICRON-CSA.html>

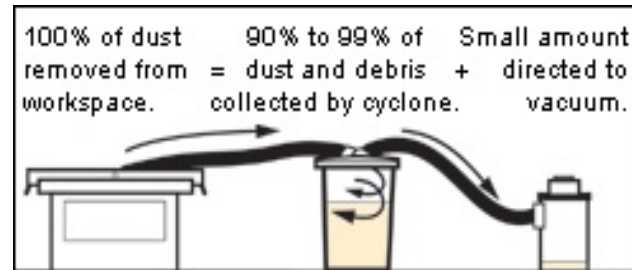
A little further along in the *Outillage 2000* catalogue they have a replacement filter for the upper bag. It filters down to $5(1?)\mu\text{m}$ and it comes with handles to shake the dust down into the lower bag.

(<http://www.outillage2000.com/Machines-bois-Aspirateurs-Cartouche-filtrante-pour-fines-particules-p-2256.html>). The site states one value in the text and another in the summary.

2. Another type of "dust collection" is the cyclone. If you swirl water in the kitchen sink and let it drain, you'll see a cyclone in action. It differs from the bag method in that it adds gravity to separate dust from the air. There are two types of cyclone action. They are noted below.

- a. **Garbage Can Lid:** The cheapest to buy or make is the garbage can lid. All this does is sit on top of the garbage can. One hose is at an angle next to the edge and another is in the middle. The hose in the middle of the lid is connected to the vacuum cleaner. The vacuum lowers the pressure in the garbage can which, in

turn, lowers the pressure in the hose to the tool. The ambient air pressure pushes the dust and air into the hose and gets pushed into the garbage can. The particles that are heavier than air (just about all the dust) fall to the bottom of the can. Because of the location of the holes in the lid, a secondary effect, the cyclonic action, creates a centrifugal force that spins still more heavy particles onto the side of the garbage can which drop to the bottom. The remaining particles (typically the very fine ones) in the airstream get pushed into the vacuum and filtered out in the vacuum filter. I use a drywall dust bag in my vacuum. I don't have any filtration specs for this because it is totally dependant on the filter in the vacuum cleaner. I suppose that you might actually find a HEPA filter for this arrangement. The disadvantage to this system is the dust cannot be allowed to get more than 6-7 inches from the lid. My experience says empty it when it is $\frac{3}{4}$ full. Here's a shop-built version and a commercial version:



<http://www.leevalley.com/en/wood/page.aspx?p=30282&cat=1,42401>

<http://www.cgallery.com/jpthien/cy.htm>

<http://www.leevalley.com/en/wood/page.aspx?p=30282&cat=1,42401>

- b. **Funnel:** This is similar to the garbage can lid but the cyclone action is separated from the collection action. The dust separation is also more thorough because the cyclonic action of the funnel is more forceful and longer than the garbage can lid. The separation of cyclone and collection also improves dust separation. The principal design, and the benchmark, is Bill Pentz'. There are a variety of copies available on the market and there are plenty of plans showing how these work and how to make them. They are more difficult to implement than the garbage can lid but worth the effort. BusyBee states its filtration at $1\mu\text{m}$. This is the same filter sold in the French Outillage2000.com catalogue noted above. Just the filter sells for 230,00 € and filters to $5\mu\text{m}$. «Ultra performant, ce système permet de filtrer les très fines poussières (jusqu'à 5 microns).» "Ultra performing, this system permits filtering very fine dust (down to $5\mu\text{m}$)."



There are several versions of the funnel separator available, some big, some small. *Oneida Air Systems - Dust Deputy* appears to be a most direct copy of the one designed by Bill Pentz.

Here are more links to dust collection methods:

<http://www.routerforums.com/table-mounted-routing/21764-building-dust-collector.html#post185854>

<http://www.routerforums.com/shop-safety/21824-review-rockler-dust-collection-separator-small.html#post186610>

<http://www.routerforums.com/tools-woodworking/15742-lucky-me-new-cyclone.html#post128460>

One of our members from Belgium has prepared a design of his own. Santé's homebuilt dust collection installation and design http://www.lescopeaux.asso.fr/Equipe_ment_Atelier/clic.php?url=Docs/Sante_Cyclone.pdf Even if you don't read French, this is well worth the look see. Pictures can say a thousand words. If you have any questions, just ask. Santé reads and writes English and there are other members who speak French who can also help.

Preventing Dust?

Sharpen your blades: Dull tools make more dust. A dull blade will not cut through the wood cell but will crush it into a million fragments, each like a piece of broken glass. If your planer blades are getting dull but not at the point of replacement, yet, expect more dust than with sharp blades. You might try honing your blades to keep them sharper longer.

Clean your blades and bits: Gum and dirt will impede the efficient action of your cutting tools. Clean them frequently. There are a variety of cleaners from vendors of all types. I use 99% isopropyl alcohol and a brass brush. Works a charm. The 99% isopropyl alcohol is available at your local chemist. A 49% version, used as a rub for sore muscles, is available on store shelves but doesn't clean as well as 99%.

The air filter: Ok, we've collected the sawdust from the tool, sucked it into fan, blew it into a bag and straight through the bag and into the air. Remember, the cotton bag, according to the Outillage2000, will filter out $35\mu\text{m}$ particles. That means anything smaller than $35\mu\text{m}$ gets propelled completely through the bag and into your lungs. At that rate, you'll smoke tobacco for protection. Sorry, locoweed doesn't count!☹ Thus, we need a second process to render the air breathable.

The Minimum Efficiency Reporting Value (MERV): No dust collection system can collect all of the particles that get flung around. That leaves the need for an air cleaning method. Typically, this is a blower with some sort of fine filtering.

Over time, technology started to measure airborne particles in terms of microns. All you could figure was that if your filter was rated at $10\mu\text{m}$ that was pretty coarse and $1\mu\text{m}$ was pretty fine. In 2012, that no longer is sufficient. Now we have "MERV ratings." This chart is copied from:

<http://www.fridgefilters.com/air-filter-glossary.html>

MERV rating	Particle Size		
	0.3 - 1.0 μ m	1.0-3.0 μ m	3.0-10.0 μ m
1-4	—	—	Less than 20%
5	—	—	20-35%
6	—	—	35-50%
7	—	—	50-70%
8	—	—	70-85%
9	—	Less than 50%	More than 85%
10	—	50-65%	More than 85%
11	—	65-80%	More than 85%
12	—	80-90%	More than 90%
13	Less than 75%	More than 90%	More than 90%
14	75-85%	More than 90%	More than 90%
15	85-95%	More than 90%	More than 90%
16	More than 95%	More than 95%	More than 95%
17	> 99.97 on 0.30 μ m particles, IEST* Type A		
18	> 99.99 on 0.30 μ m particles, IEST* Type C		
19	> 99.999 on 0.30 μ m particles, IEST* Type D		
20	> 99.9999 on 0.10–0.20 μ m particles, IEST* Type F		

* Institute of Environmental Sciences and Technology (IEST)

Read the chart from left to right as follows:

A filter with a MERV rating of 14...








1. Will capture 75 - 85% of particles that are between 0.3 and 1 μ m in size
2. Will capture more than 90% of particles that are between 1 & 3 μ m.
3. Will capture more than 90% of particles that are between 3 and 10 μ m

Please note that ASHRAE (the American Society of Heating, Refrigerating, and Air-Conditioning Engineers) created the MERV standard from 1 to 16. The MERV 17 to 20 is an addition by the IEST. The MERV standard is used to assess the filtering power of a furnace filter/air cleaner. I don't know what the function of the IEST addition is.

The microparticle: This is where things get really confusing and downright misleading. Look at the chart, *Typical Household Contaminant Sizes*. See the neat section that refers to “fine particles”? The 3M information that I came across implied, but didn't state, that the 3M filters specifically targeted their Filtrete filters at the category labelled “microparticles”.

You can easily get thoroughly confused when reading 3M materials. To simplify matters, I refer you to this chart and the subsequent text:

We found this chart at the iallergy.com website: <http://www.iallergy.com/filtrete-air-filter-comparison.php>.

							
Description	Entry Level	Basic	Good	Better	Better	Best	Best
Available in:	17 sizes	24 sizes	31 sizes	32 sizes	7 sizes	22 sizes	7 sizes
MPR Rating	300	600	1000	1500	1500	1900	2200
MERV Rating	7	8	11	11	11	12	12
* Efficiency	60%	70%	80%	90%	90%	93%	94%
Pressure Drop	0.15	0.14	0.21	0.19	0.19	0.21	0.21
Captures	Large allergens, such as: household dust and pollen	Dust Reduction + dust-mite debris and lint.	Dust & Pollen + mold spores, and pet dander. Small allergens, such as: smoke, smog, and bacteria.	Micro Allergen + "and particles that can carry viruses.	Ultra Allergen + "and particles that can carry viruses."	Ultra Allergen + "and particles that can carry odors."	The same as Ultimate Allergen +
Summary:	Most economical Filtrete Filter available	Lowest pressure drop of any Filtrete Filter	Most economical "High-Performance" Filter	High-Performance Filter	Same performance as "Ultra" at clearance prices in select sizes	Premium High-Performance Filter	The absolute best quality filter, available in select sizes

Don't fall for the hype. These are only a maximum of MERV 12 filters. None of these 3M filters address our problem of particles under $1.0\mu\text{m}$ in size. However, like me, there are lots of markets where this is the only available filter. Alternatively, I have to import them, and that becomes a real pain.

They go on to say:

About 3M Filtrete 1" Air Filters:

3M Filtrete filters contain electrostatically charged filter media made of polypropylene and polyolefin plastic, and capture particles that measure between 0.3 - 10 microns in size. The electrostatic properties cause the filter to act like a magnet, helping it to attract both large and small particles into the filter's pleated fabric. 3M Filtrete filters, when clean and new, outperform all other fiberglass, washable and non-electrostatic 1" residential air filters.

MERV and 3M Performance Rating:

MERV (Minimum Efficiency Reporting Value) is a number from 1 to 12 produced from an air filtration test designed by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). The MERV rating is designed to help you compare the effectiveness of various air filters, with a higher MERV rating indicating better filtration performance. 3M also produces their own independent ratings which focus instead on a filter's ability to capture the smallest particles and allergens measured in the ASHRAE test. Using particle data between 0.3 and 1 microns in size, the Microparticle Performance Rating (MPR) is 3M's way of demonstrating their filter's superiority at capturing the smallest microscopic particles. A higher MPR rating indicates a more effective 3M Filtrete filter.

Recommended Replacement:

Filtrete furnace filters should be replaced at least once every 3 months. When clean and new, Filtrete filters do not restrict airflow. After the Filtrete furnace filter has been in your system for 3 months, and depending on your usage and environment, it may begin to restrict airflow. Certain conditions in your home will significantly add particles to the air causing the filter to capture more particles than usual. This will shorten the filter life to less than 3 months and reduce the effectiveness of the filter to capture particles. These conditions include: Dirty Ductwork, Construction Work, Sanding Projects, Pets, Burning Candles, Tobacco Smoke and Fireplace/Wood-Burning Stove Smoke. In addition, running your furnace or air conditioning fan continuously will help clean the air in your home more effectively, but could further shorten the life of the filter. So, if you use a Filtrete filter under these conditions, it could begin to restrict airflow, especially in energy efficient furnace and air conditioning systems. In these cases, it is recommended to change the filter more frequently. Actual filter life will vary depending on your living conditions.

To determine when the filter needs to be changed, hold the filter up to a light source. If you cannot see any light through the filter, it should be changed even if it has been used less than 3 months.

<http://www.iallergy.com/filtrete-air-filter-comparison.php>

The HEPA: You often see High-Efficiency Particulate Air (HEPA) filters touted on vacuum cleaners etc. There is a large component to the HEPA standard. Go to Wikipedia to get all of the information. In short, HEPA filters "remove at least 99.97% of airborne particles 0.3 micrometers (μm) in diameter" (<http://en.wikipedia.org/wiki/HEPA>.) I don't know how HEPA compares to MERV and MPR.

The FPR (Air Filter Performance Rating): was created by Home Depot in the United States. It doesn't seem to have any correlation to anything or any other standard. They seem to have taken other measuring systems and homogenized them. I can't make any sense out of their information on their website: http://www.homedepot.com/webapp/catalog/servlet/ContentView?pn=Air_Filters I can only think it is a smoke screen to improve their margins on filters. It is interesting to note that these "FPR grades" don't exist on the Canadian version of the Home Depot site, nor on the products on the store shelves in Canada.

Here's where things get really frustrating. It didn't take much digging for me to assemble this information package. All of the information is readily and openly available. In Canada we have a dominant merchant that sells a lot of furnace filters. Canadian Tire Corporation has >475 stores and \$9 Billion in sales. Their online catalogue doesn't note MERV numbers in most of their filter descriptions. They have a dedicated buyer who must know this stuff and still they feel it is not necessary to pass it on to the consumer let alone allow us to compare products and make an informed decision. What's really frustrating is when you go to a store and the dominant vendor on the shelf has an offering at \$41.99 that has no grading or rating of any kind so, it is no better than the filter sold in a package of three for \$3.99. If you base quality on price do you deserve to be robbed?

Here's the next bit of frustration. My "inside contact" tells me that Aprilair and AirBear brands both have their filters independently tested. I could find information on the AirBear and their MERV 8 & 11 filters are tested to "Tested using ANSI/ASHRAE 52.2 - 2007 standard procedures." I could find no corroboration for the Aprilair products, but, I trust my source.

So, what to do? Well, the best filtering methodology is to exhaust dust outside. You don't need filters for that and you remove the problem quickly and efficiently. But, you also dump the problem, potentially, on your neighbours. For me, that is not an option. We get winters of -40°C and heat is expensive. Thus, I examined the commercial offerings and then, created my own solution. **Please note that more expensive is definitely not better.**

The commercial offering: This is one of the BusyBee air filters. It seems typical of all commercial offerings from dirt cheap to fancy and expensive. In spite of the hype, they're essentially identical. This one moves ≤ 1400 cubic feet per minute of air through the filters. They state that the two stage filter system removes 98% of dust ≥ 1 micron. Another vendor boasts 99% of $\geq 5\mu\text{m}$ and 85% of $\geq 1\mu\text{m}$. BusyBee in their top-of-the-line air cleaner boasts a $5\mu\text{m}$ primary filter and a $1\mu\text{m}$ secondary filter. That's supposed to be better than MERV 12, but MERV 12 doesn't even address particles under $1\mu\text{m}$ and that's the size that does the damage.



http://www.busybeetools.com/product_images/50/1950/CT051_zoom.jpg

The homebuilt offering: My solution is a 2100 CFM, 24" box fan with 20" x 20" x 1" thick furnace filters, stacked. In this instance it gives me a 4" progressive filter stack attached to the intake side of the fan. I combine filters to keep most of the larger particles out of the fine filters leaving them to be more efficient. OK, I use ...

- primary filters - two, unmarked, stacked filters of the 3 for \$3.99 variety - they're the brown ones for large particles.
- secondary filter - MERV 8 (Garrison Allergen Furnace Filters, 2-pk @ \$9.99) you can almost read MERV8 hand written on it for as much fines as possible.
- tertiary filter - MERV 12 (MPR 1900 3M Filtrete® Maximum Allergen Filter @ \$21.74 ea. [on sale].) That's the black lined one.



Now, I have to say that I used the two unmarked primary filters only because I had them and I figured somehow I had to make up 4" of filtering. I also figured that the two coarse filters will help keep the big stuff out of the finer filters prolonging their lives. This does not address particles under $1.0\mu\text{m}$ but I'm hoping my slower fan speed and multiple filters will help. Finding finer filters than MERV 12 right now appears to be a daunting and expensive task. So, I've also taken to wearing a protective mask over my nose and mouth when I'm working with stuff like MDF.

I attached the filters to the fan body using some pallet wrap. This blocked off all parts of the fan intake side that were not covered by filter so the airflow was as total as I could make it. The filters are all designed for use in a forced air furnace so the filters are robust. Unless a filter is designed to be washed, they are single use. Once plugged, discard. What is missing is the deflectors that I haven't built, yet.

One of my sources provided that my fan will move air through the filters slower than a furnace fan will which is good for trapping smaller particles. That gives me improved(theoretically) particle removal, hopefully, down to $0.3\mu\text{m}$. Compare that to the commercial offerings:

Parameter	Commercial offering	Homebuilt version
Cubic Feet per Minute (CFM) (high speed)	Ca. 1400	Ca. 2100 (estimated)
Filtering smallest particles	$1\mu\text{m}$ unrated	maybe $0.3\mu\text{m}$???
primary filter	$5\mu\text{m}$ unrated	if it removes $10\mu\text{m}$, I'm happy
Secondary filter	$1\mu\text{m}$ unrated	MERV 8-12 (depending on budget)
tertiary filter	nope	1900-2200 MPR = MERV 12
speeds	more speeds more \$	what's available
timer to signal when to replace filter	optional	nope, eyeball to check the filter
HP of fan	$\frac{1}{4}$ - $\frac{1}{3}$ HP	
motor voltage	115V	
current	$3\frac{1}{2}$ A	
fancy grill, touch pads, remote control, designed to burn expensive filters, anything to increase the price...	yup	nope, use filters according to your needs and means

I used my router to run a bunch of long rabbits that normally would create a storm of dust. I turned on the fan and ran the router without dust collection. A few minutes of the fan running and there was no dust in the air. I determined that by looking into the beam of one of my work lights. Prior to this filter stack, I could see clouds of dust.

In this I use BusyBee products as a reference point. You'll find that most vendors offer a version of what BusyBee offers. There are actually very few manufacturers of any given tool but there are lots of vendors offering the same tool with slight "adjustments" to make them "unique" to a brand. No matter what brand you examine, the BusyBee will be a good representation.

Air filter location: One of the things that is less clear is where best to position the air filter. The only information I could find was on the Powermatic manual for their model 1791330. *"This unit will work best if located away from corners and heating/cooling vents."* The BusyBee manual had something similar but less conspicuous. So, I put the question to the membership of the forum and came up with some excellent information.

One of this forum's members provided that there are two types of workshop, the in-home and the stand-alone.

- I. **The in-home workshop:** has some major problems. No matter how hard you try, the dust will carry throughout the entire house. It gets worse if you use a forced air furnace but don't think that if you have baseboard heat that you're out of the woods. If you're married, you know all about this problem.

It must be noted that the best dust collection is to collect the dust at the source and push it immediately outside. If you have an in-home workshop, have your wife dust the house. Then, cut a piece of lumber and watch how the dust travels throughout the house. Over the next few days, you might just find your dust on the living room table.

Try to collect the dust at the source, "even if only using a shop vac;" 2nd, a stand alone dust collector with a MERV rating of at least 11; and, 3rd, use a high efficiency air cleaner on the central heating or cooling system in the home."

2. **The stand-alone workshop:** typically, is larger than the in-home shop so it has different problems. One solution is “using the dust collector as the air filter.” There’s lots of air that has to be cleaned quickly. There are two problems, one is the dust collector itself is rather coarse so you’re flinging around the finer dust particles and the other is there are “corners” and “blind spots” that trap air and it is difficult to circulate the air through those spots. The result, an air filter and it has to be positioned in the best location to move air through these blind spots. The filter should be centrally located or as close to the source of dust as possible.

I have located mine about 8" from the ceiling in the centre of the room with the filters below, and the fan blowing against the ceiling. I'll add deflectors at some point to direct the air the length of the shop. The coarse filters are exposed so I can vacuum them occasionally, picking most of the coarse dust out of the filters and extending the filter life, and reducing cost. I'll replace the finer filters only when they have a noticeable coat of dust on them.

One suggested alternative is to put the dust collection in a closet and put the air filtration on the door. I absolutely agree. At least this will reduce the amount of dust pushed around the shop from the cotton bag. My problem with this is, though, is that dust collection at a saw, for example, only collects a portion of the dust, the rest gets flung into the air. That stuff won't get filtered.

Summary

No matter what or how you implement it, unless you're using hand tools exclusively, you must take dust control seriously. Failure to do so and you're investing in a terrible death at the hands of poisons and pollution. I proffer several shop-built solutions that appear to be more effective than the commercial offerings. This is no guarantee and I hope things will change in the future but do your homework. Make sure what you are purchasing or constructing is actually functional and not providing false hope. My objective is to provide stimulus for thought, not give you misleading information that may prove dangerous in the future.

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