The Basics of Dust Extraction
An AMSA Resource

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Australian Men's Shed Association
SHOULDER TO SHOULDER

The Basics of Dust Extraction

Importance of Dust Extraction

Professional workshops have known for decades that one of the most important pieces of machinery in the workshop is an adequate extractor.

A clean, dust-free workplace:

- Safer and less work in the long run
- Less cleanup
- Less airborne dust which is very important when it comes to the finishing stage.
- It is far better for your machinery to have this dust and shavings removed.
  Other than being forced back around the cutting area and affecting the quality of the work, fine dust particles can be sucked into electrical components, build up on moving parts or pile up in areas underneath machinery (becoming a fire hazard in the process). Worst of all, these particles can find their way into your lungs.

Dust extraction is NOT a replacement for PPE (Personal Protective Equipment) but if it reduces the dust in your immediate work area, it means your PPE is going to work much more efficiently.

Running machinery without dust extraction may also affect your warranty if something does go wrong.

Extractor vs. Vacuum Cleaner

Most workshops have access to a vacuum cleaner. It really comes down to a simple rule - vacuums are made to vacuum and extractors are made to extract. Vacuum cleaners work on the principle of a low volume of air travelling at high velocity, while extractors work on high volume air travelling at low velocity. Vacuums are great for lifting small quantities of fine dust from the bottom of your carpet through a small diameter hose.

Dust extractors, on the other hand, are designed to cope with the quantity of waste constantly being produced and the large diameter hose means no blockages (provided you have enough air volume).

Air volume is measured in cubic feet per minute (CFM) and even a small, basic 1HP extractor is going to give you 600+ CFM of air flow. Most cutting/drilling machinery will require at least 600 CFM of extraction. Edge planers or jointers need slightly more (depending on size), but large milling machines such as thicknessers will require at least 800-900 CFM at the extraction point on the machine. This is an important consideration before selecting a system for your Shed.

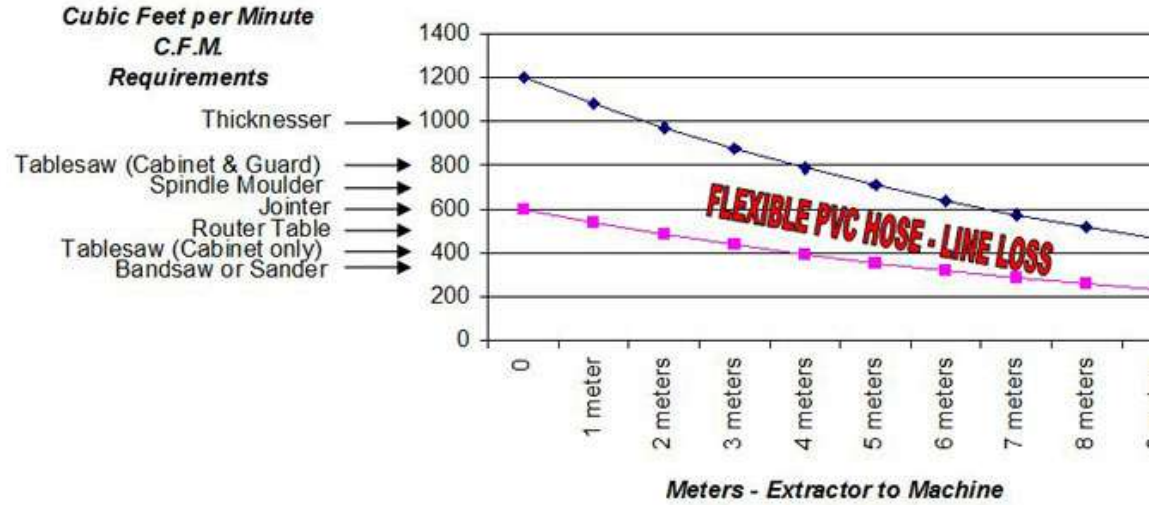
Flexible Hose

Most woodworking machinery will be provided with a large diameter extraction connection. This will usually be a 100mm or 125mm connection. This should marry nicely to your dust extractor, either directly or with some form of adaptor.

An important factor in the operational efficiency of your dust collection system is the positioning of the dust collector, in relation to the machine. Many people have designed elaborate systems, utilising Y-pieces to increase the quantity of machines connected, blast gates (switches to close off the air flow to one of more points) and running many metres of flexible hose up the wall and across the ceiling, back to the extractor.

When they switch the system on, they wonder why the suction at the far end is barely enough to be audible, never mind suck several kilos of timber waste.

For every metre of flexible hose you run, you are going to lose approximately 10-20% of your volume (CFM), and for every bend and fitting, you are going to lose an even more CFM.



Look closely at the flexible hose - every single ridge of the hose that the air has to run across is disrupting the efficient flow of the air, and in turn, the waste. If you want to run a larger system, make sure you have enough suction volume at the start, to ensure you don't run out at the business end.

Professionally designed and installed workshop systems use rigid metal pipes, with a smooth finish and engineered bends to increase efficiency- they run very high capacity dust extractors which will allow all machines to be run at the same time.

Suction loss on these systems is usually only about 1-2% per metre, but the purchase and set up cost is very high. The straighter and simpler (and shorter) you can keep your extraction system, the better. A bigger CFM is always better.

Dust Extractor Safety

One hazard that is often overlooked in dust extraction equipment is the danger of the build up of **static electricity**. The dry timber particles rubbing the inside of the flexible hose are constantly building a static charge, in the same way rubbing a plastic comb through your hair will build up a static charge.

Static, when it discharges as a spark, is just one of three parts required to create an explosion. The other two parts are **a fuel** (in the form of fine dust particles) and **air** (which is being forced through the system). Explosions in dust extraction systems are rare, but they do happen.

A simple solution to avoid this situation is to ground your system. Fitting a grounding kit to the inside of the flexible hose and connecting the wire to both the machine and the dust extractor will minimise or eliminate static from the system.

Selecting Your Dust Extractor

Determining which extractor is right for your Shed will depend heavily on what you want to do with it. If you only want to hook it up to the table saw, a very basic unit will do the job. However, if you want to connect it to your thicknesser or jointer, you need to start at a 2HP unit with a higher CFM rating and a larger waste holding capacity.

It is important to think ahead about what your future requirements will be. If you're planning to add more machinery later and you don't want to move your extractor between machinery, invest in a larger unit that will allow you to add extra points without sacrificing too much performance.

Designing small workshop extraction systems

You need to look at requirements, specifically considering which machines you have and which machines you plan to add.
Each type of machine has a certain airflow requirement for effective dust extraction. A very basic list of machines and their minimum requirements:

- Bandsaw: 300cfm
- Table saw: 400cfm (cabinet connection only)
- Router Table: 500cfm
- Jointer or Small Thicknesser: 600cfm
- Spindle Moulder: 700cfm
- Table saw 800cfm (cabinet and overhead guard)
- Lathes 800cfm
- Large Thicknesser: 1000cfm

These requirements are approximate and are of course heavily dependent on your usage and the type of material being used.

Refining an existing system

Go back to basics, strip out some of the fittings, straighten the lines and simplify the whole design. A couple of percent here and there will help.

Note also that these specs refer to the extraction requirements *at the machine* (where the hose meets the machine's dust port), not the listed capacity of the dust extractor. To work this out you need to take into account the distance between the extractor and the machine, the machine type and the type of ducting used (flexible or rigid), as well as fittings, bends, etc. This way we can calculate an approximate line loss value across the entire system.

Planning

You need to:

- Do a good scale drawing of you workshop layout
- Position your machines in their 'in-use' location
- Figure out how you want to connect them
- Decide where your dust extractor will reside
- Try to keep the heavy producers of waste (like thicknesser, lathes etc) closer to the extractor
- Draw out your desired plan, keeping the main line as straight as possible
- List 'Y' Junctions, 'T' pieces, connections, bends and blast gates and total your hose requirements
- To calculate your approximate line loss across the system, use the following rules of thumb:
    - Every metre of 100mm flexible hose will reduce your CFM by around 7 - 10% per meter. Keep it short.
    - 90 deg bends will restrict airflow by 3-4% each
    - N 'Y' Junctions will divide the airflow in half if both sides are left open (use blast gates to switch off the unused side)
    - A gated 'Y' Junction will reduce airflow by around 1-2% each.
    - N 'T' pieces are fairly inefficient compared to 'Y' junctions. They will reduce the airflow by 3-4% each.
- Stepping down to a smaller diameter will increase the velocity but will lower the CFM airflow considerably
- Use minimal reducers and try to keep them near the end of the line and near the machines that produce smaller amounts of dust (scroll saws, mitre saws etc)
- KEEP IT SIMPLE

Other Options for Ducting

Flexible PVC ducting and metal ducted networks

Largely because flexible PVC is such a cheap and simple option, metal ducting has been out of the reach of most small workshops.

There are versatile DIY metal ducting networks available that will marry easily to exiting flexible networks or make a great starting point for a new setup. The efficiencies you gain with rigid ducting versus flexible PVC are dramatic. Using rule of thumb listed above, with rigid ducting will have:

- line loss of only about 1% per metre
- 90 deg bends will restrict airflow by only about 1% each due to their larger radius and constant diameter
- 'Y' Junctions will still divide the airflow in half if both sides are left open (use blast gates to switch off the unused side).
- A gated 'Y' Junction will reduce airflow by around 1%
- 'T' pieces are not used with rigid ducting due to their inefficient properties
- Stepping down is usually done through a long conical reducer which is far more efficient- recommend placing these near the end of the system.

This sort of rigid ducting network would have enough straights, bends, corners, junctions and fittings to put together a pretty substantial and professional dust system in a workshop up to about 6 meters long with 3 outlets.

Overall, you would lose only about 15-17% total CFM. The equivalent system in flexible PVC would reduce your CFM by about 70%.

Types of Dust Extractors

Technically speaking, the commonly used dust extractors are broken down into two main categories: baffle chamber and cyclonic separation. There are variations but usually these two are what you will find.

The more common and less expensive **Baffle Chamber** (or standard bag type) dust extractor uses a motor to spin a centrifugal impeller that - through its clever blade design - sucks air in through the centre of the fan and pushes it out toward the sides of the fan.

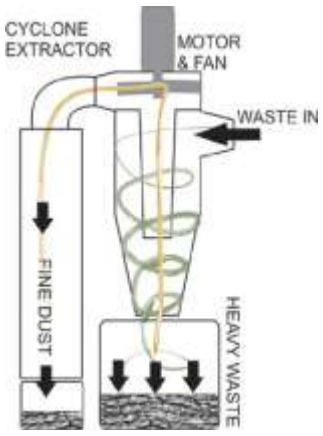
Manufacturers design extractors so that the inbound waste follows this air path, through the impeller and into a collection chamber. The change in air direction once we get to this chamber (and gravity helps here), causes the heavier waste to fall down and the lighter dust particles to rise up. These are caught in a filter on the top. This filter can be either a cloth or felt bag or a more elaborate pleated filter cartridge.

Cyclonic Separation is not a new concept. It has been available for industrial use for many years but has only become accessible and affordable to the general public within the past decade.

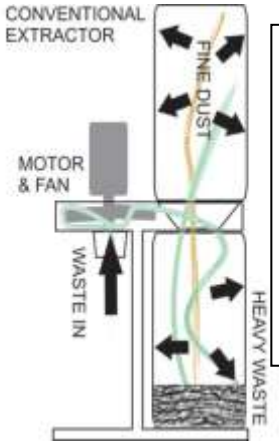
Cyclones differ from standard bag extractors in many ways. Their design and build is far superior and the technology involved is far more efficient. Again, a motor is used to spin a centrifugal impeller, but whereas the impeller on the standard bag extractor was in line with the waste flow, the cyclone has two different paths.

The airflow path pulls the waste into the collection chamber but from there it uses directional baffles to divert waste material. Basic theories of thermodynamics and some high end aspects of quantum physics come into play and effectively the waste flow path sees the material spun rapidly around the outside cone and it is then forced down to the bottom of the collection chamber, leaving the airflow path free of heavy waste.

The remaining fine dust particles are then sucked through the impeller and pushed out into a small collection bag.



Cyclonic machines run consistently with maximum efficiency and constant air flow...



...while traditional baffle chamber type extractors run less efficiently, with airflow being affected by various factors

The main difference between standard bag and a cyclone is performance.

Cyclones run at lower CFM rating than equivalent bag type extractors. This is due to the extreme efficiencies gained in the design. No longer is the actual CFM reading jumping up and down, due to the heavy waste material bouncing off and running through the impeller. The suction pressure being applied to the system is constant and uninterrupted. Cyclones efficiently deal with the heavy waste material and separate this from the fine dust.

Performance Enhancements for Existing Systems
On a standard bag system the fine dust is pushed up and is forced into the fabric filter bag. This fine dust needs to be cleaned occasionally by hitting the outside of the bag or by blasting it with compressed air.

After-market cartridge filters can be added to most standard bag type extractors. These cartridge filters (which look like a very large car air filter) replace the standard fitted top filter bag and improve the outward airflow. Their greater surface gives the fine particles a larger area to settle into, and most cartridge filters will have internal cleaning brushes to aid with periodic maintenance.

In-line dust separators are available to reduce the volume of waste material before it gets to the impeller of your dust extractor. These usually sit on top of a large plastic rubbish bin in line before your collector. These work quite well but will affect the CFM airflow.

Upgrading your existing flexible PVC network to a rigid system will be a huge enhancement. The cost of this upgrade may well be less than buying a larger extractor and plugging it onto your inefficient flexible PVC network (for little or no increase in performance).

So what is my best option?
There is no right answer but there is always a wrong answer.

The best option for both collection networks and dust collections is always going to be dependent on your own collection of machinery, how big your workshop is and where you see yourself in a year's time.

The wrong option is deliberately designing a system that's 'just enough' or not quite enough to do the job. The money you save now will soon be forgotten when it comes time to fix the problems.

This information has been sourced and adapted from Carbatec Knowledge Articles
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