How to Properly Size a Dehumidifier

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19 January 2024

By Tim De Stasio
January 19, 2024

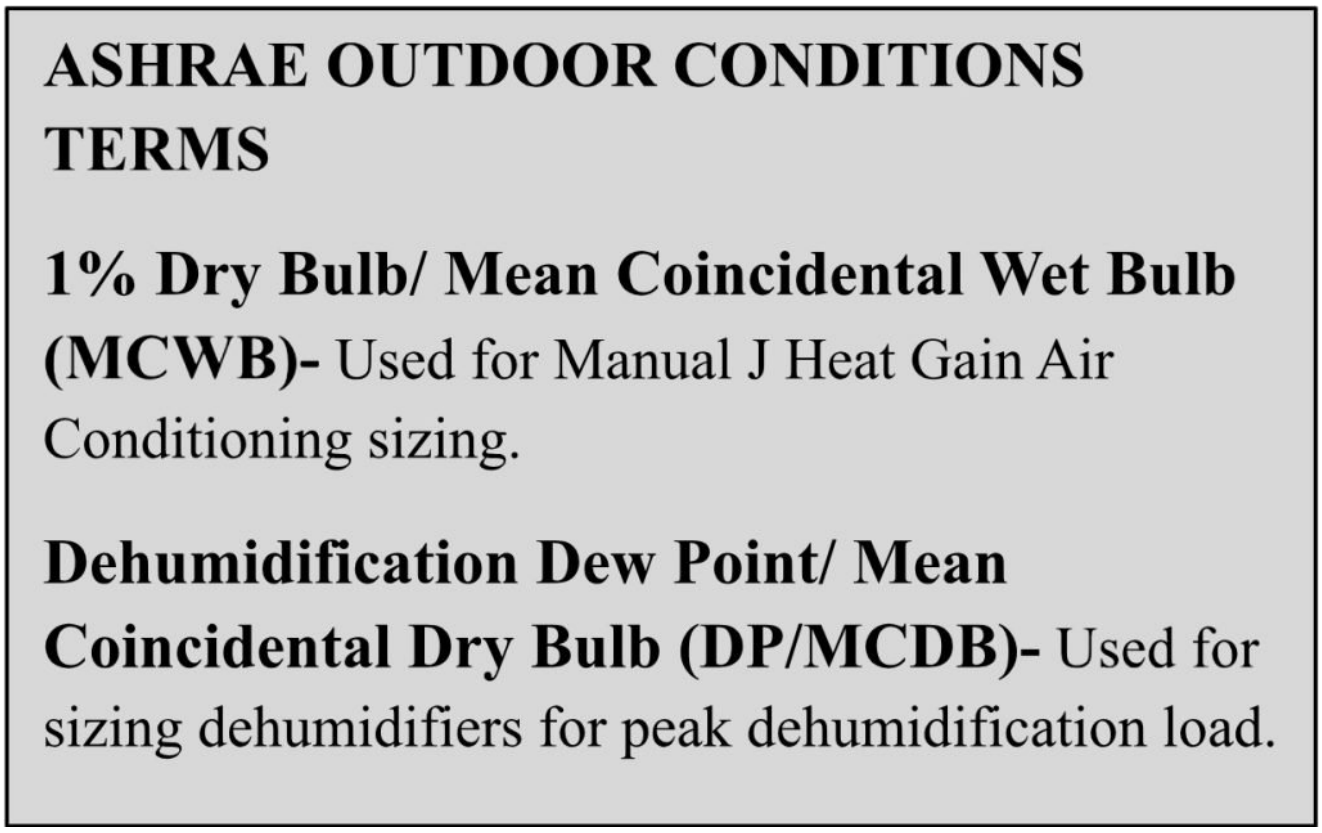
This tech tip was submitted to us by Tim De Stasio. You can read the original version on his website HERE. Tim will also be a panelist in the Dehumidification Hootenanny at the 2024 HVACR Training Symposium. Nikki Krueger will moderate, and Genry Garcia, Chris Hughes, and Chris Conway will be fellow panelists.

If you've been consuming any progressive HVAC or Building Science content, you probably already realize that most homes would benefit from dehumidification. Some require more hours of it per year than others. This has a lot to do with the climate, infiltration, duct leakage, and ventilation.

Sizing a dehumidifier is not simply a matter of matching the square foot recommendations on the OEM literature to your home's floor area. Nor is it simply an equation converting the latent load to pints per day (PPD). Another common misconception is that "you can't oversize a dehumidifier." It doesn't have to be a complicated process either since most OEMs only offer a handful of models in their lineup anyway. The discerning contractor, with a little bit of math, can select the right dehumidifier every time.

Know The True Dehumidification Load

Start with understanding the latent load from a detailed Manual J. The important part is knowing the outdoor conditions that will produce the *most* moisture, called the **peak dehumidification load**. This is NOT the same outdoor conditions as the ASHRAE 1% Dry Bulb/ Mean Coincidental Wet Bulb (DB/MCWB) that we use to size the main AC with Manual J. Rather, ASHRAE also publishes the Dehumidification Dew Point/ Mean Coincidental Dry Bulb (DP/MCDB). These conditions are typically a few degrees cooler but more humid (more grains/ higher dewpoint).



The wettest day of the year is rarely one of the hottest.

What do you do with that information? First, make a copy of your heat load calculation that will be used to size the main HVAC equipment. The copy will be your dehumidification load calculation. Change the outdoor design conditions to the DP/MCDB conditions instead. You'll

find the sensible load will usually go down, but the latent load will go up. Since we are asking the dehumidifier to handle 100% of the latent load, simply convert that load to PPD.

PPD = BTU/H Latent ÷ 1054 X 24

There are a lot of forces that affect the latent load. On new buildings, we need to know the target envelope and duct leakage and the ventilation rate, then make sure this is verified during testing. On existing buildings, we will need to do this testing ourselves and, to the extent possible, quantify and improve these. Within infiltration, there are other forces you should understand, such as depressurization, duct leakage, and stack effect. Selecting “tight”, “average” or “loose” infiltration on a Manual J is not enough.

Decouple The Latent Load

At the time of this article’s writing, the latest Manual S guidance on sizing dehumidifiers has not been officially released. I got the opportunity to view the proposed changes, and it seems that the industry is shifting towards an approach that decouples the latent load away from the main AC and hands it over to the dehumidifier. The advantage of this approach is that we remove all doubt that the moisture load will be handled. It allows us to aggressively size the AC to handle the sensible load, which is how newer equipment is being designed in order to meet efficiency standards. I’ve been using this approach for a few years, and it works very well, with some added limits.

The disadvantage that I see with this approach is that it doesn’t account for the latent contributions that the main AC will provide. During times when the moisture load isn’t as high, the dehumidifier could be grossly oversized. The dangers of oversizing a dehumidifier will be discussed later in this article.

A Pint For A Pint (Not Really)

So far, we’ve covered how to calculate the Pints Per Day (PPD) load. The next step is to match a dehumidifier to that load.

> ***Dehumidifier capacity can drastically be reduced because:***
>
> ***1. Entering air conditions are different than the conditions used to rate the unit.***
>
> ***2. Dehumidifier airflow is reduced due to poor ductwork.***

There are 2 predominant entering air conditions that are used to rate dehumidifier capacity. The most common is the Association of Home Appliance Manufacturers (AHAM) 80°F/ 60%. As you know from basic psychrometrics, warmer air can hold more moisture. Imagine

squeezing juice from an orange. When you first squeeze it, you get a lot of “juice for the squeeze.” This is what happens when 80°F/60% passes through a dehumidifier. There is a lot of moisture present, and the dehumidifier easily removes a lot of it.

The other commonly used design conditions are the Department of Energy (DOE) 73°F/60%. Because the air is a little cooler, it can’t hold as much moisture, so not as much gets removed when it passes through the dehumidifier. It’s like trying to squeeze juice out of an orange that’s already been squeezed. The result is that the DOE's capacity is lower than that of the AHAM.

Neither of these rating conditions represents the indoor design conditions that Manual J calls for, which are 75°F/50-55%. Unless the manufacturer provides capacity at those conditions, we are forced to extrapolate per Manual S. We could use this unofficial table to adjust the capacity from rated conditions to 75°F/50%.

CAPACITY ADJUSTMENTS			
AHAM PPD @ 80°/ 60%	**DOE PPD @ 73°F/ 60%**	**Manual J PPD @ 75°/ 50%**	**Manual J Latent BTU/H @ 75°/ 50%**
70	55	45.5	1998
98	72	63.7	2797
120	79	78.6	3454
155	104	101	4435
205	171	133	5852

Or you could use Santa Fe Products, who **publish their performance data**. This is just one of the many reasons why I exclusively use Santa Fe dehumidifiers.

If your dehumidifier is ventilating, remember that the entering air conditions will be significantly higher than 75°F/50%. Santa Fe publishes a Maximum Recommended Ventilation Air CFM.

In the absence of information from other OEMs, never mix more than 30% outside air with return air, as this can overload the dehumidifier with more moisture than it can handle.

You can perform a quick Mixed Air calculation using the **Munters Psychro App.** The 2024 Manual S should give further specific guidance on how to adjust dehumidifier capacity in the absence of OEM information.

As with any HVAC equipment, airflow can make or break its performance. Dehumidifiers are no different. It's imperative to design dehumidifier ductwork for as little static pressure as possible. Some dehumidifier OEMs, such as Santa Fe, will publish the airflow at a specified **total static pressure**. Some models perform better than others. Many times, a dehumidifier installation also must be coupled with duct modifications. There is a lot more guidance about dehumidifier installation best practices, but that's not the intent of this article.

There will be times when peak sensible and latent loads will spike higher than your calculations called for. Always insert language into your contracts that acknowledges this as normal and temporary.

This information should stress the need to do the math and know the product line that you sell. If you don't, you may not meet the expectations of your customers.

Is It Possible To Oversize a Dehumidifier?

The short answer is yes. An oversized dehumidifier will short cycle. The same reasons apply to a dehumidifier as do a short cycling AC. When the unit cycles on, it is using energy, but for the first few minutes, the coil is not below dewpoint and is not removing humidity. When it cycles off, the water on the coil evaporates back into the air, adding to the moisture load. Remember, the dehumidifier also adds sensible heat, which is an additional energy penalty. We accept that penalty as long as it is removing moisture, but an oversized dehumidifier doesn't do that.

This brings us to the other main reason why we shouldn't oversize a dehumidifier. Most dehumidifiers put out hot, dry air. This is because they work like miniature AC units. The condenser is downstream of the evaporator and reheats the air before it leaves the unit.

This adds sensible load to the building that must be figured into the load calculation for the main HVAC system. Most dehumidifiers put out around 100°F air. Compared to the indoor design temperature of 75°F, this creates a 25°F temperature difference. We can use the **sensible heat formula** below to estimate the sensible gain from the dehumidifier.

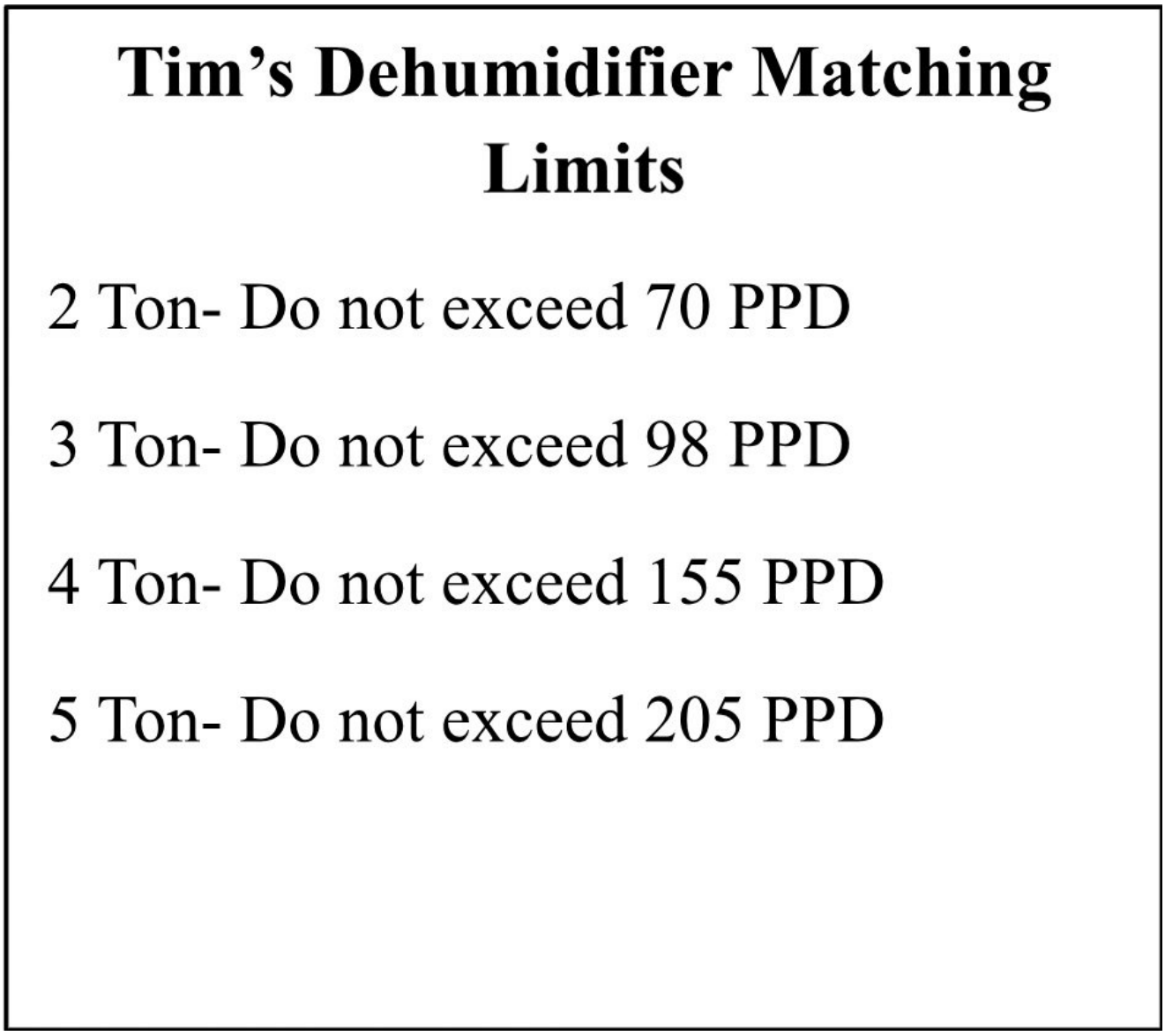
Sensible BTU/H = Temperature Diff. X CFM X 1.1

A 98 PPD unit can add around half a ton of extra sensible heat that the AC needs to be able to handle! Theoretically, the dehumidifier would only run during mild weather when there is less sensible load for the AC. In fact, adding to the sensible load would increase the AC's run time, assisting with dehumidification.

If a home has a very high latent load, there may be hot days when both the AC and the dehumidifier will run at the same time to meet a 50% R.H. setpoint. Will the AC still be able to control the temperature? Understand your load calculation and the capacity of your

equipment. Controls such as the Santa Fe DEH3000R may need to be installed to prevent this; these lock out the dehumidifier when the AC runs. An interesting exercise is to calculate the supply air outlet temperature that results from mixing the two airstreams.

Let's say that we are installing the 98 PPD dehumidifier with a 2-ton AC at 800 CFM with a 55°F supply temperature. Using the **Munters Psychro App,** the expected supply outlet temperature would be around 63°. Supplying 63° air into a room may create comfort complaints. This teaches us something. It IS possible to mismatch a dehumidifier with an AC if they run together. Based on Santa Fe's published performance charts, I have set limits to the dehumidifiers I match up with AC systems if I expect them to run congruently.



Don't Overthink It

In summary, there are more considerations to sizing and selecting dehumidifiers than many contractors realize. But remember, you only have four or five dehumidifier models to choose from. If you apply my matching limits, this probably narrows it down to two. So, while the math is important, it really boils down to selecting between two units anyway.

So, don't spend hours upon hours sizing a dehumidifier. Spend that time planning *how you will install it*. Ducting and controls have a large effect on whether the installation solves the problem or creates new ones. Fortunately, HVAC School has a lot of content about dehumidifier installation best practices, and there is no shortage of practitioners who are more than happy to help you.

—Tim De Stasio

#dehumidification #dehumidifier #equipment sizing