

Keep the Water Out with Desiccant Air Dryers

What is Desiccant?

Desiccant is an exceptionally adsorbent material due to its high affinity to water. In addition, they pull moisture from the air due to their hygroscopic properties. In other words, it can keep the area in immediate contact with the air dry by removing all the moisture into the center of the bead and containing it to allow more water to be adsorbed. This process continues until the beads become entirely saturated and need to be switched out.

By using a desiccant air dryer, you can prevent wear and tear on your components that are highly sensitive to water. To be able to perform this process of air drying, specific materials need to be used. These materials are often chemically stable, but a few potentially toxic options require specific conditions to be used. The most commonly used desiccant includes but is not limited to:

- Silica
- Calcium Chloride
- Activated Charcoal
- Calcium Sulfate

Due to the high quantities of water in compressed air and to extend desiccant life, these dryers often rely on two towers filled with desiccant. As the air passes over them, the water is adsorbed, and eventually, the beads will not be able to hold anymore. These towers are designed so that before the desiccant reaches full saturation, they will switch how the air flows between towers. One will go from removing moisture to being dried and vice versa.

Depending on the style of the dryer, the way that the desiccant is dried differs. Just know that the desiccant needs to be dried when it is not in use to prevent early saturation and reduced performance from your dryer. We will detail the different types of desiccant air dryers and how they operate in just a bit.

In Between The Desiccant

As we mentioned, these desiccant air dryers consist of two towers filled with an adsorbent material. When the air is being passed through the dryer, one building is

dedicated to actively drying the air while the second tower is undergoing desiccant regeneration. This regeneration process is simply drying out the beads so they can absorb more moisture when the towers are switched back.

Having a control panel that can automatically reverse the flow of air depending on the desiccant's saturation is hugely beneficial to the efficiency and longevity of the materials. This allows you to maximize your air-drying potential on each cycle. In addition, this provides for long drying and regeneration cycles. This alternation will continue until the beads can no longer retain moisture and the material needs to be switched out.

The drying process is relatively straightforward with these dryers; the confusion comes when determining how you would like your desiccant to be regenerated. Differences arise between the models through the processes and what is used to regenerate the desiccant. The three main models of regeneration in dryers are:

- Heatless Pressure Swing
- Heated Regeneration
- Heat of Compression

These dryers could be described as hot air regeneration, dry compressed air regeneration, and special drying systems. Although they may sound confusing, the processes of regeneration and their classifications are pretty self-explanatory. So let's examine these machines on a closer level.

Heatless Pressure Swing Dryer

Heatless Pressure dryers only use compressed air as purge air. Now, if you are unsure what purge air is, that is the air used to dry out the desiccant. In the case of a heatless dryer, a portion of the air that has been dried is redirected into the tower that is in the regeneration phase.

By using dry compressed air, no extra energy is needed to dry the desiccant out. The problem arises when you consider how expensive compressed air is from an energy standpoint. Using the valuable compressed air as purge reduces the volume produced by your compressor as the air used to dry the desiccant is not cycled back through. These air dryers typically require a purge rate of around 17-20% of the total airflow.

These dryers are classified under desiccant regeneration using compressed air; pretty self-explanatory when you know how heatless works. This classification means the dryer uses a portion of dried compressed air that has just passed through, and this saves extra energy costs that may be needed for other methods of desiccant regeneration.

Heated Regenerative Dryer

Compressed air is such a valuable resource when it comes to cost, and if you are someone who does not want to waste much compressed air, a heated regenerative may be the best bet for you. These dryers use a hot air blower or an internal heating system to heat ambient air to the point of being able to regenerate the desiccant. These dryers often use less than 7% purge rate during this process, which is a lot lower than a heatless desiccant.

It may come as a surprise, but these dryers are classified under hot air desiccant regeneration. A stream of hot air is passed through the saturated desiccant to remove the moisture from within the beads. This classification requires the use of a fan or internal electrical heating system to get the air up to the temperature that is needed while saving valuable compressed air. Rather than using air from in the system, heated atmospheric air is used to dry out the desiccant.

Heat of Compression

Unlike the other forms of regeneration, heat of compression is much less common and that is due to the fact that it can only be used with oil-free compressors. This is because of the excess heat that comes off from an oil-free compressor due to the lack of something to remove heat in the compression chamber of the compressor. This heat would then be rerouted to the dryers so that regeneration can occur.

Similar to heated regenerative desiccant air dryers, these dryers are considered hot air desiccant regeneration. The air just does not need to be heated up, at least not to the same degree. In this scenario the heat is simply moved from the compressor to the desiccant dryer to be used for the regeneration phase. This process can lower the dewpoint down to -50°F.

How Do I Pick a Desiccant Air Dryer?

When it comes to picking out a desiccant air dryer, there are few extra factors you are going to want to take into consideration, aside from the information you would be expected to know. As we know not all dryers are built the same, and different models excel in different environments and conditions. This variety of information that is needed can make it difficult to weed out the options that won't work for you.

Now these extra factors that you are going to want to focus on include:

- Pressure Drop
- Regeneration Costs
- Desiccant Use
- Pre-Filters
- After-Filter
- Valve Adjustments

A few of these extra considerations may seem obvious, but it doesn't hurt to make sure you have checked all of those factors. In order to understand what you should be looking for, we will go into all of them in further detail.

Pressure Drop

When you are using a compressed air dryer, regardless of the style, it is going to create a pressure drop. This pressure drop will result in the air being produced to exit the dryer at a lower pressure than when it went in. For instance, if you need 90 PSI of air to operate and your dryer has a pressure drop of 2 PSI, then you will need the compressor to be outputting 92 PSI to ensure that with the pressure drop you are still meeting your requirements.

Keep in mind, the bigger your compressor gets, the more expensive it is to increase the pressure on the air. Be sure to keep your necessary PSI and what your compressor is rated for when you are looking at an air dryer. It would be unfortunate to have all the information right but if you do not calculate for pressure drop, that can be the difference between your system working as expected or having problems due to inadequate pressure.

Regeneration Costs

Regeneration costs are dependent on the style of desiccant air dryer that you go with. If you select a heated air dryer, you will need to consider the energy costs needed to heat the regeneration air. Now if you have a heatless dryer your focus will not be on energy costs, instead it is on how much air is lost with purge air.

Typically this is going to be between 15-20% of your compressed air that is being created, and that stuff does not come cheap. You are going to be losing up to a fifth of the compressed air you produce. Essentially your machine will only be outputting $\frac{4}{5}$ of its total capacity when it is connected to a heatless desiccant dryer.

Desiccant Use

Even after going through the process of regeneration, the desiccant will eventually be worn down to the point where it no longer can hold any moisture and it is completely saturated. Once desiccant has reached this point, it will allow moisture to continue downstream and potentially cause problems at the point of use.

It is important to keep in mind the cost of desiccant and the lifespan of the desiccant you choose. Knowing this information will allow you to stay on top of changing out the materials and knowing how much it will cost to properly operate and maintain your compressed air dryer. Typically these beads will need to be replaced every few years, but depending on your duty cycle that could change.

Pre-Filters

Compressed air is naturally dirty, as all the particles that were existing in a large volume of space were compressed together. Pre-filters are a necessity to remove those contaminants before they reach the air dryer, especially your desiccant dryers. If other particulates make their way into the chamber, the desiccant can become contaminated or have reduced efficiency.

When oil comes into contact with desiccant, it acts differently than water. Oil will coat the outside of the desiccant and prevent the water from being able to get through, both in and out. In order to prevent this from happening, it is strongly suggested to have filtration for water droplets and oil prior to your air dryer so that the dryer can do its job.

After-Filter

Just like you need the pre-filter to make sure the desiccant can do its job, you need an after filter to cover for the desiccant. Time can be detrimental to your desiccant and this will cause them to deteriorate and send desiccant-dust downstream. In order to protect against dust particles. The easiest way to do this would be the use of a particulate filter after the dryer to catch any particles that may be tagging along with the airstream that shouldn't be.

Valve Adjustments

When it comes to your valves and making sure your equipment is set up properly, there are a few things you will want to change:

- Starting Pressure of Safety Valve: 1.05 times inlet pressure
- Pneumatic Shut-Off Valve: 0.3-0.5 MPA
- Adjust Ball Valve Q: About 4-6% of gas volume

Some Last Minute Reminders

Condensation is the killer of compressed air system. Issues can be caused downstream by the moisture that can be anything from clogging tools to creating fisheyes when you are trying to paint something. It can be expensive to replace these components or undergo maintenance. These costs can include:

- Labor for Repairs
- Parts for Repairs
- Damage to Products
- Production Downtime

When you are relying on purge air to regenerate your desiccant, the purge rate is based on the nameplate and the rating there. The purge control on these machines is simply a crack or hole that feeds the air back into the towers. This allows for the air to have a fixed flow rate and pressure for the side that is being regenerated, without causing disparities in the flow of air.

Applications:

When it comes to dryers, you either need a desiccant or a refrigerated unit, and you should know which one you need when you go looking to get one. The point of switching from refrigerant to desiccant is determined by the quality of air you need, if you need air dryer to a critical degree then you should only be looking for a desiccant.

The most common applications for desiccant air dryers are:

- Plastic Molding
- Electronics Production
- Power Plant
- Food & Beverage
- Laser Cutting

The main thing you want to focus on is how the air is being used in your application. If it is an application where moisture will cause problems that can make your product unusable or have potentially catastrophic problems occur. When you are working in these industries moisture needs to be removed at all costs.

Now you might not be in an industry where you need a desiccant dryer, but your location may make the difference between what dryer you need. If you live up north where the temperature can get really low, the ambient air can cool the pipes after the dryer and cause more moisture to drop out of the air because it is being cooled even more after being dried.

In a refrigerant dryer the air would be below 40°F after it exits the dryer, but if the ambient air is below that it will cool it even more in the pipes.

If you live in an environment where the temperature can get below freezing and your pipes go outdoors, then you will want to consider a desiccant even if your application is not one that needs one. You could also use desiccant seasonally if it was possible so that you did not have to use one year round, but would still be able to work through those challenging conditions.

Before You Buy

So before you go off and buy your own desiccant air dryer, let's review why you may

want to get one and the benefits that these dryers can provide.

Traditionally, desiccant is stored in two towers so that while one is drying the air the other is being regenerated by purge air or heated air. This cycle of regeneration is dependent on demand, dew point, the moisture present in the desiccant, or a combination of factors. These dryers work year round with no problem due to the dew point can be made by a desiccant. These dryers have the capability to filter moisture in air that is as low as -100°F.

The main advantages of these dryers are:

- **Easy Maintenance**
- **Low Dewpoint Capabilities**
- **Excels At Second Stage Drying**

Most desiccant dryers come with an added bonus, a small sight-glass that lets you see a portion of desiccant beads. These beads are not used in the actual drying process but serve as an indicator for the moisture in the dryer. It will change color if there's too much water in the air to let you know you might want to change which tower is regenerating and drying. With this information, you can check and see how the dryer is performing at a glance.