The Two Minute Solutionizer

EVENT IMPACT ON REFRIGERATED DRYER PERFORMANCE

On the discharge side of the dryer, the velocity is critical to the results for the system whether or not you have a final filter. The earlier two-minute Solutionizer called “selecting refrigerated air dryers” we mentioned that you have to control the temperature in and the velocity out. When design velocity is exceeded even if you have 10-15% design factor built in, two things can occur. First, there is insufficient contact time to achieve the desired dew point. Second, turbulence can occur in the quiet zone of the final dryer separator. Both of these issues will result in liquid water and or higher dew point than designed. Let’s examine each situation and the potential solutions.

If you have a rate of flow exceeding the capacity of the dryer, it will result in insufficient contact time in the refrigeration air to refrigerant heat exchanger. This can occur for a short time as a result of an event that occurs while the dryer is already base loaded to its maximum capacity. Consider a system with a 28.3 m^3/min (1000-cfm) compressor in standby and a second compressor operating at roughly 25.48 m^3/min (900-cfm). If a momentary event occurs with a rate of flow of 5.66 m^3/min (200-cfm) for 5 seconds, the total flow through the dryer is 31.1 m^3/min (1100-cfm). This would be enough to start up the stand-by compressor. The event causes the pressure to drop on the downstream side of the dryer. If the event occurs faster than the reaction speed to start the next compressor, then the pressure will fall faster on the downstream side of the dryer than on the upstream. (Note that the dryer usually has the highest differential between the event and the compressor). This is called a suction negative rate of change. When the compressor responds, the differential will diminish and eventually subside. During the five seconds, the velocity will exceed the appropriate contact time and results in water downstream that will condense out as water in the piping. Depending on the frequency of the event and duration, the problem can result in a little or a lot of water downstream. If the separator’s design capacity is exceeded, moisture that would normally be pulled out of the air stream will pass downstream too thereby increasing the total amount of moisture. Where dryers are top of the frame these are more susceptible to this than middle or bottom of the frame dryers.

If the continuous usage of the system exceeds the capacity of the dryer, the differential will exceed the rated differential and the system’s dew point will be much higher than the dryer rating. If the dew point is sufficiently high, it may result in continuous water downstream. Even if it doesn’t show up as liquid water, it could show up as frosting on the discharge orifices of the tools, valves, and instruments, which will restrict airflow and performance. The air can cool as much as 5 to 8°C because of the rapid adiabatic cooling at the exhaust. If the dew point is more than the resulting temperature of the air, water will condense. You have to be careful diagnosing this because a high relative humidity at atmosphere can also cause the same result from time to time.

No upstream treatment will prevent these problems. You could install a larger or lower dew point dryer but this is an expensive solution in capital and operating cost. You must have sufficient storage downstream of the dryer to support the event or events with clean dry air to minimize the pressure decay at the dryer discharge. Let's say that the pressure drops 0.69-barg (10-psig) in 5 seconds.

If the measured supply storage is 8.2m³/bar (20 cf/psi) (8200-litres of storage), then the size of the event was 5.66 m³ (200-cf) and the rate of flow was 67.9 m³/min (2399 cfm). (5.66 m³ in 5 seconds).

Size of the event in volume = storage in m³/bar x pressure drop. (8.2 m³ x 0.69 = 5.66 m³)

Rate of flow in m³/min = event volume / time of event in seconds x 60 seconds
(5.66 m³ / 5 x 60 = 67.9 m³/min)

To size the required storage, you multiply the event in volume times the atmospheric pressure divided by the desired pressure drop.

In this case, those values are 5.66 m³ and we'll assume atmospheric pressure of 1 bar (14.5-psi) and an allowable pressure drop of 0.27 bar (4-psi). This would be 21 m³ (742 cf) of dry storage.

Storage = event volume m³ x P1/PD (5.66 m³/min x 1.0/0.27 = 21 m³)

If we divide this value by the atmospheric pressure, we get 21 m³/bar (51 cf/psi). If we subtract the existing dry storage of 8.2m³/bar (20 scf/psi), we need 12.8 m³/bar (31 cf/psi) to support the event, eliminate the velocity problem and prevent an added compressor from loading. Therefore the additional storage required to handle a 5.66 m³ event for 5 seconds is 12,800-litres.

This storage solution solves the cleanliness problem and reduces the operating cost of the system. If the demand pressure can be reduced, adding an Intelliflow downstream of the new storage tank can create additional savings. If this 5.66 m³ (200 cf) event occurs every 10 minutes, then the event looks like a 0.566 m³/min (20-cfm) demand and requires a fraction of the energy if the event would normally turn on another compressor.

Learn to do this type of work well so that you can demonstrate your knowledge base on paper and in front of the client. Selecting appropriate dry storage will eliminate overloading of dryers and avoid turning on additional compressors. All the smoke and mirrors that your competition can conjure up can't compete with this type of "solutionizing". You have measured and defined the problem and engineered a precise solution. Be careful to this work in conjunction with an audit solution so that the value you and IR bring to the customer is not given away thereby reducing it to a commodity purchase. You must remain part of the solution.

Glossary
Event – system or customer demand