C.E.R. TECH NOTES

Controlled Environment Room Technical Application Newsletter

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Design and Application Issue:
Selecting A Dehumidification Method

Controlled Environment Rooms (CERs) can be designed to meet a wide variety of performance requirements, one of which is low relative humidity. This moisture level reduction in the chamber air can be accomplished in a variety of ways. The dehumidification method selected will have an impact on first cost, regular maintenance commitment, installation space considerations, energy cost, and certain elements of humidity control performance. Invest time to learn about the merits of the two most widely used methods in the industry and you will be well served by your final selection.

Two dehumidification methods widely applied in the industry are adsorption and condensation. Both have more familiar names. Condensation, often specified as "dehumidification by refrigeration" or a similar phrase, is accomplished by passing air across a surface which is cold enough to condense absorbed moisture, reducing the total moisture content of the air. If the temperature of the air on the discharge side of this process is below the chamber setpoint, it must be reheated prior to entering the work zone.

Adsorption, the trapping of water molecules on the surface of a material (the desiccant), is the second method of dehumidification employed. The equipment set for this dehumidification process is often referred to as a "drier". Within this unit, desiccant is contained in a slowly rotating bed or wheel. Chamber air is drawn through the bed, exposing it to the moisture scavenging activity of the desiccant. The resultant dry air is then discharged back into the controlled space. The rotation of the bed moves the desiccant through a reactivation zone where it is exposed to a continuous flow of heated ambient air. This reactivation air is hot enough to remove the moisture which is trapped on the desiccant surface. The moisture laden air is then discharged to the surrounding space or an exhaust duct..

Assume, for simplicity, that both methods can achieve the desired control accuracy. The decision will then focus on reliability, cost of ownership, secondary effects of the dehumidification method on overall system operation, and the impact on the stored product or process. Review CER usage patterns, keeping the following questions in mind:

What is the lowest dew point to be maintained? Desiccant systems can be initially and continually more cost effective when achieving very low moisture levels. In CER operation, these conditions are often combined with low air temperatures where refrigeration based dehumidification is less efficient. Conversely, if the desired dew point is reasonably high, a refrigeration based system can be an effective method of dehumidification, requiring little or no additional equipment.

Will the CER be required to maintain a wide array of moisture conditions, some of which will not need dehumidification? A refrigeration based system will generally have a larger cooling capacity than a desiccant based system, since it needs to provide latent as well as sensible cooling. If dehumidification is not required for an operating setpoint, a means must exist to control the excess cooling system capacity no longer needed for dehumidification. Since most CERs have continuously operating compressors, the energy consumption and cost will remain constant, even when dehumidification is not needed. A desiccant based system is provided as a separate equipment unit which can be shut down when not needed.

How severely will the product or process be affected by recurring increases in the room moisture

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More on selecting the appropriate dehumidification system.

level? Refrigeration based dehumidification designs maintaining sufficiently low moisture levels will have coil surfaces that accumulate frost and ice as they dehumidify the chamber air. These systems must be defrosted to maintain their rated performance. While defrosting, there will be an increase in the chamber relative humidity. The dehumidifying coil is out of commission during defrost. As heat is applied to the frost and ice to melt it, some evaporation will occur, increasing the chamber relative humidity. If the dehumidifying coil is responsible for cooling the chamber air, there will be a notable increase in work zone temperature too.

Desiccant based dehumidifiers continuously regenerate their adsorptive material, negating any need to stop the moisture removal process. In some cases, dehumidification by desiccant can reduce or eliminate the normal defrost cycles associated with cold room operation.

How reliably will the equipment be maintained? It is safe to say that all desiccant based units have moving parts which may require periodic adjustment or lubrication. There are also air flow dampers and other regulating devices which must be maintained in the proper position and balance. The desiccant must be periodically replaced and can be damaged by extreme operating conditions. There are air filters which need regular replacement.

Refrigeration based systems require little maintenance. It is common to design this type of system utilizing the temperature control cooling system as the dehumidifying unit, so there is little additional hardware involved.

How quickly will the system recover the setpoint conditions after a disturbance? Both methods can theoretically be applied in sufficient capacity to provide any practical recovery period. However, given a wide range of possible disturbance conditions, the recovery performance of a desiccant based system is more predictable and repeatable than a refrigerant based design. This is because the desiccant dehumidifier has only a single function....directly removing moisture from the air. The cooling system on the refrigeration based design must divide its capacity between the sensible (dry) and latent (wet) loads associated with a disturbance. If a particular disturbance has a large amount of coincidental heat gain, this heat must be removed prior to any moisture removal. This makes the recovery performance of this method less predictable than the desiccant system, which maintains its rated dehumidifying capacity under similar conditions.

What is the first cost impact? It depends upon the desired moisture level. Generally, a refrigerant based system costs less to purchase, requiring only an increase in the "regular" system capacity to chill and reheat the circulated air. A desiccant system entails the purchase and installation of additional equipment, ductwork, and electrical circuitry not found on the other system.

There are space considerations too. A desiccant unit should be located adjacent to the CER enclosure to minimize connecting ductwork length. Service access and ventilation are needed. Refrigerant based systems may require some additional ceiling space within the chamber, but externally are without special restriction. Part of the system, the condensing unit, can be located remotely, even outdoors.

So, which is the best choice? Low chamber moisture levels favor a desiccant unit in price and performance. At higher moisture levels, refrigeration based systems can provide comparable performance with lower first cost and maintenance. If the CER has a wide operating range, the desiccant system can be shut down when not needed, saving energy. Desiccant units have no normal off cycle, providing continuous performance. They can reduce defrosting requirements in cold rooms.

There are many angles of approach to implementing a dehumidification process. Determine the factors having the greatest impact on your work. Formulate design goals around your requirements. Evaluate the extent to which each dehumidification method can achieve successful performance. The invested effort will bring a better understanding of this important process, as well as realistic expectations of controlled environment room performance.

Insert this document in your Climate Technologies Design Guide binder for future reference. Need a binder? Call our office. We will send you a registered binder that will assure that you receive our latest information.