Adsorbents Solutions for Compressed Air Drying

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Why drying?

The compression of humid ambient air, for example in an industrial application, produces liquid water by condensation. If the application does not allow moisture for chemical-physical reasons or danger arises due to the precipitation of the moisture, the compressed air must be dried.

The maximum water vapor content of a compressed air volume unit is caused by the temperature of the compressed air and is almost completely independent of its pressure. The water vapor content is therefore theoretically represented by the dew point, which indicates the temperature at which the actual water vapor quantity corresponds to a relative humidity of 100 % and below which condensation begins.

Drying in this context means a reduction of the dew point below the actual operating temperature. To obtain ultra-dry air (ISO 8573.1 class 1, 2 or 3), essentially only the process of adsorption, in which water is bound to a solid body (the adsorbent) via physical binding forces. Desorption, on the other hand, refers to the release of the adsorbate from the adsorbent. Since binding forces. Desorption, on the other hand, refers to the release of the adsorbate from the adsorbent. Since the adsorption capacity of adsorbents decreases with increasing temperature and decreasing pressure, moisture can be sorbed again by heat supply or pressure reduction.

The adsorbents used in such a drying process are high-tech desiccants and have an inner surface area of up to 1000 m²/g, due to their pore structure of macro-, meso- and micropores, where condensed water vapor can accumulate. For the drying of compressed air, silica gels, aluminum oxides (activated alumina) and zeolitic molecular sieves are most commonly used. These desiccants reach dynamic adsorption capacities above 20 % by weight and dew points down to -100 °C.

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Applications: Compressed air adsorption drying

Today adsorption dryers are part of every modern compressed air and energy supply. In addition to the correct regeneration process, the adsorbent is the actual basic process component of each adsorption dryer and is responsible not only for the physical process of adsorption but also for the efficiency of the system.

Economic systems

Where high efficiency is required specifically due to high energy costs, an adsorption dryer filled with Sorbead® Air can achieve or even exceed the required performance with a long lifetime. Compressed-air dryer manufacturers use Sorbead® Air for a long time and specify Sorbead® Air as the best option if a particularly low-energy operation is required. Energy efficiency and high reliability make Sorbead® Air the perfect choice in energy-efficient compressed air dryers compared to other adsorbents like Activated Alumina and Molecular Sieves.

External heat-regenerated (purgeless)

Low-energy external heat-regenerated adsorption dryers (Figure 1) are desorbed and cooled with drawn-in ambient energy. An external electric heater, steam or another medium can be used for heating. Modern purgeless systems (zero-purge) do not require compressed air consumption (purge air), depending on the pressure dew point with low desorption temperatures (120 to 150 °C) and are now delivered in different versions.

Pressure dew point: -25 to -60 °C
Adsorbent: Sorbead® Air R/WS

Heat-of-compression (HOC)

The Heat-of-Compression process (Figure 2) is a heat-regenerated adsorption dryer that uses the hot gas flow from an oil-free compressor for full or split stream desorption. The closed system is regenerated under pressure and the hot compressed air coming from the compressor is used for the desorption. These systems are among the most energy-saving compressed air dryers and show how efficiently dried compressed air can be produced.

Pressure dew point: -15 to -40 °C
Adsorbent: Sorbead® Air WS

Sorbead® Air WS meets the special requirements of this procedure to a continuous regenerability at high temperature and high humidity of the desorption air (dew point +60 °C).

External heat regenerated (standard)

Standard adsorption dryers (externally heat-regenerated) are desorbed with externally heated fan air like the low-energy variants. These are used if the demands on the efficiency are not too high. In contrast to the modern purgeless systems, a partial flow of compressed air (purge air) is normally required for cooling. The standard of these systems usually includes drying agents which require a significantly higher desorption temperature (170° to 200 °C.) and a larger quantity of dry regeneration air.

Pressure dew point: -25 to -40 °C
Adsorbent: Activated Alumina F 200

Standard systems

Cold regenerated (heatless)

Cold-regenerated dryers (so-called heatless dryers) function without heat but with a bit of compressed air. These pressure swing adsorption dryers require a partial flow of previously-dried air for regeneration. The change-over takes place after only a few minutes with low water adsorption of less than 1 % by weight of the drying agent. Due to the high consumption of 12 to 25 % dried compressed air depending on the operating pressure, relatively high energy costs result during operation.

Pressure dew point: -25 to -40 °C, -70 °C
Adsorbent: Activated Alumina F 200, Molecular Sieve 4A

Molecular sieves are used when particularly deep pressure dew points (up to -100 °C) are required, where the compressed air to be dried has a low relative humidity or is already pre-dried. Likewise, molecular sieves are suitable for the selective separation of gas mixtures owing to their uniform pore structure. Molecular sieves can be regenerated but require high temperatures of above 200 °C in order to reach the residual moisture required for very low dew points.

Table 2 BASF adsorbents selection table for compressed air dryers

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1As a function of the desorption temperature, PDP – Pressure dew point
280 % Sorbead® Air R and 20 % Sorbead® Air WS as protection layer
Sorbead® Air advantage: Energy savings

The efficiency of a compressed air unit is strongly influenced by the adsorption capacity, regenerability and the lifetime of the adsorbent. The lower the desorption temperature and the longer the lifetime of the adsorbent, the higher is the efficiency of a plant.

Sorbead® Air – High efficiency

Because of their high adsorption capacity and the energetically favorable regeneration conditions to achieve low pressure dew points, Sorbead® Air is the first choice for low-energy heat-regenerated adsorption dryers. Sorbead® Air is therefore the most economical and environmentally friendly adsorbent.

These benefits lead to a significant reduction in the dryer’s energy cost while using Sorbead® Air compared to standard desiccants, which can be seen in Figure 3. These energy savings can result in substantial economical savings (see example in Figure 4). Sorbead Air represents only 1.6% of the total cost of ownership (TCO) of a compressed air dryer but can result in 23% savings of that TCO.

Sorbead® Air is used in almost all industrial areas with different pressure dew points and regeneration methods, with sometimes an above-average lifetime of up to 10 years (see Figure 5).

Operators of compressed air units appreciate the high efficiency and the long lifetime of Sorbead® Air, because of the combination of the following unique properties:

- High adsorption capacity due to large specific surface area and pore volume
- Low desorption temperatures to achieve low pressure dew points and good desorption in moist regenerating air
- Abrasion resistance and low pressure drop
- Good mechanical and thermal stability and high chemical resistance
- Long lifetime and low maintenance requirements
- Known to be safe due to many years of use in heat regenerated dryers

Sorbead® Air is a registered trademark of BASF and is intended for use as an adsorbent. Sorbead® Air is made in Germany and is manufactured at the BASF plant in Nienburg/Weser.

Sorbead® Air meets the highest quality requirements and can be clearly identified by its CAS-Register number. In addition, it meets the requirements of the European Chemicals Regulation REACH, which is intended to ensure a high level of protection for human beings and the environment.

For new adsorption units BASF recommends using one of the economical systems based on Sorbead® Air. Compressed air operators can improve the efficiency of their adsorption dryer with the support of BASF’s technical service and by the use of Sorbead® Air.
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BASF – We create chemistry

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