

Relative humidity (RH) and condensation

Relative humidity (RH, expressed as %) is used to describe the amount of water vapor in a mixture of air and water vapor. A relationship exists between RH, temperature and condensation. Condensation occurs on surfaces that are colder than a specific temperature (dew point) at a given RH and air temperature. At higher RH, the dew point rises, allowing condensation to occur with smaller temperature drops. As a result, a drop of just 5°C will already cause condensation in high humidity environments [41].

Humidity decreases with altitude, while proximity to large bodies of water and the presence of moisture-bearing winds result in a higher humidity. The most humid cities on earth are generally located closer to the equator, near coastal regions or near large bodies of water. Average RH for Democratic Republic of Congo (DRC) for instance is not below 70%, while the coastal areas in East-Africa can have a RH that reaches 95%. Rainy season and monsoon season will increase the RH temporarily, so that condensation can occur more easily during that time.

Silica gel

Silica gel is not a gel but it presents as porous beads or granules. The micro-porous structure (with an average pore size of 24 Å [42]) offers a very large surface area (800m²/g) by which silica beads can adsorb water molecules to up to 8-40% of their own weight [41,42]. Hereby the relative humidity (RH) inside a closed environment can be reduced to below 50% [41]. Silica gel performs best at high humidity (RH 60-90%) and at room temperature (21 - 32°C), but will lose its adsorption capacity below RH 40% and at higher temperatures (> 105°C), making regeneration and reuse of the silica beads possible [42].

The term “self-indicating silica gel” refers to the presence of silica beads coated with a humidity indicator which – by change of its color – alerts when the maximum absorption capacity has been reached. There are different colors, depending on the type of indicator used: cobalt dichloride (blue in dry state, pink in saturated state)[41], methyl violet (orange in dry state, green in saturated state)[43] or iron salts (orange in dry state, colorless in saturated state)[41] (Figure 4).

The silica beads are packed in a vapor-permeable sachet to allow humidity uptake. This can be made out of different materials like breathable tea-bag paper, non-woven fabrics, TyvekTM or breathable cotton paper [41,44].

Molecular sieve

Molecular sieve is a synthetic and porous type of silicate and is available as beads or bars. The pore size openings are uniform (3, 4, 5 or 10 Å) allowing the selective adsorption of specifically sized molecules. As a result molecular sieve is useful to dry a product without removing other desirable compounds within the system. It is efficient at high temperatures (up to 225°C) and at low relative humidity environments. It can reduce the relative humidity to 1% RH and it will not give up the adsorbed humidity easily when the temperature rises. A disadvantage is the higher cost per unit compared to the other desiccant types [42].

Montmorillonite clay

Montmorillonite clay is a naturally occurring porous adsorbent, that is activated by careful drying, and is produced as beads or granules. It can regenerate at very low temperatures without deterioration or swelling. As a result humidity will be released easily once the temperature rises. This type of desiccant works well at temperatures below 50°C and is the least expensive type of desiccant available [42].