SATURATED SALT SOLUTIONS FOR CONTROLLING RELATIVE HUMIDITY

The water vapour concentration, and therefore the relative humidity over a salt solution is less than that over pure water. This is because water is present in both the gas and the liquid phase, whereas the scarcely volatile salt molecules are only present in the liquid. They dilute the water and hinder escape of water molecules into the air. The rate of return of water molecules to the liquid surface is proportional to their concentration in the gas, where there are no salt ions to interfere. The system therefore adjusts to an equilibrium where there are fewer water molecules in the air than there would be over a pure water surface. The RH is therefore lower than 100%.

This argument applies to all salt solutions, saturated or not. The reason for using saturated solutions, in contact with a heap of the solid crystals, is that the concentration theoretically remains constant even if water enters or leaves the solution from the air.

In practice there are some problems with saturated salt solutions. They are difficult to wash out of art objects after accidents. The salt tends to crystallise at the edges of the container. The crystals form a labyrinth that allows solution to rise by capillarity and crystallise further up the wall. Eventually the salt gets everywhere.

A less well known problem is that the salt solution is bad at dehumidifying. During this process the saturated solution begins to absorb water from the air. This dilutes the solution at the surface. The less dense surface solution is gravitationally stable and does not mix with the bulk of saturated solution, so the RH drifts upwards from the theoretical value for the saturated solution towards 100%. If the room temperature is unstable the salt solution behaves quite unpredictably, causing considerable errors when such solutions are used in experimental work to measure absorption isotherms or to calibrate instruments.

The situation can be improved by heaping up the solid salt in a cone, with just enough water to damp it. Extra solution formed by water absorption from the air will dribble down the outside of the cone, exposing a fresh crystal surface to grab more water from the air. Convective mixing can also be achieved by enclosing the saturated solution in a polymer sachet that is permeable to water molecules but not to charged ions. Thin silicone sheet is good for this purpose but now the job is so complicated that it is better to use another RH control method altogether.

Mechanical mixing is possible but messy and brings the extra uncertainty that the mixer adds heat to the solution, resulting in a higher than theoretical RH at the surface of the object being conditioned.

Source: http://www.conservationphysics.org/satslt/satsol.php