

Transpiration of Water Vapour In Dry Air Systems

All materials are permeable to water vapour, as the water molecule is extremely small compared to the structure of solids, especially when compared to the polymer construction of plastics, and even to the crystalline structure of metals.

Dalton's law states that the overall pressure of a gas equals the sum of pressures exerted by its constituents. Air at 1 BarA may contain 75% Nitrogen, 21% Oxygen, 3% Carbon Dioxide, the rest made up of other gases including water vapour, hence 0.75 BarA is exerted by Nitrogen, 0.21 BarA exerted by oxygen etc... At an ambient of 20 °C and a relative humidity of 50%, water vapour comprises 1.2% of the atmosphere. The partial pressure exerted on the outside of a compressed air line will be 11.7 mBarA. If the dry air inside is pressurised to 8 BarA at -50 °C Dewpoint, the partial pressure exerted by the compressed air's water vapour is 0.039 mBarA. We now have atmospheric water vapour at 11.7 mBarA pushing through a porous medium against a dry air water vapour pressure of just 0.039 mBarA. Naturally water will migrate into the pressurised air line! This is transpiration.

Another factor that will affect dry air systems is adsorption and desorption. Materials will act like sponges to moisture to varying extents. A plastic air line will adsorb moisture onto its structure, and will release it into dry air. Initially when dry air flows through plastic pipe, it will collect a lot of water, the pick up will slow down over time but never stop as transpiration takes over.

Over a long pipe run, water will inevitably migrate into any line, even through the most resistant materials; it should not be assumed that the moisture on the outlet to line will be the same as on the inlet.

The best materials to resist these effects are stainless steel and PTFE. Galvanised Steel and Copper are satisfactory at lower dewpoints. Another consideration with high purity systems are the integrity of all connections. If a small leak occurs in a high pressure line of course gas will leak out, but vortices at the leak point and a negative vapour pressure differential will allow water vapour to contaminate the flow.

It is important then designing a dry air system that all these factors are taken into consideration. In order to maintain a good repeatable dry air system, we recommend:-

- ▶ Careful consideration is taken when selecting materials.
- ▶ For flexible lines only ever use PTFE, - NEVER PLASTICS OR RUBBERS.
- ▶ Maintain good quality connectors
- ▶ Use the smallest bore pipe possible to ensure the volume is swept frequently.