GIEBEL Adsorber®
...setting standards in aeration drying!

GIEBEL ADSORBER® DESIGNED AND PRODUCED IN GERMANY

Use of hydrophobic PTFE membranes for water separation

Properties of PTFE

Polytetrafluoroethylene or PTFE is a synthetic fluoropolymer of tetrafluoroethylene. This material is known for its chemical resistance, thermal stability and excellent hydrophobicity. PTFE is a simple polymer consisting of the two elements carbon and fluorine. The covalent compounds C-C and C-F are extremely strong. In addition, fluorine is the most electronegative element in the periodic table, which does not release its electrons. For this reason, PTFE has a low surface energy. High surface energy liquids, such as e.g. Water, difficult to wet the surface, which leads to the good hydrophobicity of PTFE. In a special manufacturing process, expanded PTFE membranes (ePTFE) are produced, which have a highly compressed structure and nevertheless an 85% porosity. These membranes are very breathable and defined pores.

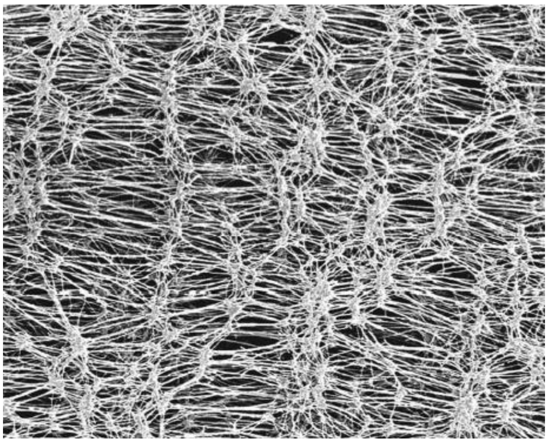


Figure 1: Electron micrograph of an ePTFE structure.

Seperation of water droplets

PTFE membranes are used, among other things, as pressure compensation elements. Electronic components must be able to withstand enormous differences in temperature and pressure, for example due to the fact that the housings heated during operation come into contact with cold spray water. These pressure differences can stress the housing seals and fatigue over time, allowing water to penetrate and destroy the electronics. To prevent the entry of water, dirt and vermin, the ventilation elements are used. About the membrane pores, which are about 20,000 times smaller than a drop of water, there is a continuous air and pressure equalization. By an additional oleophobic coating can be achieved that also beads off oils and chemicals and not wet the membrane.

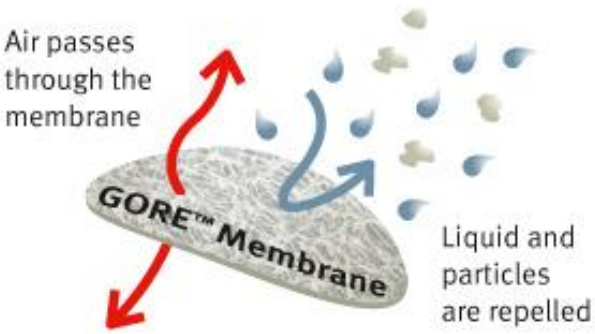
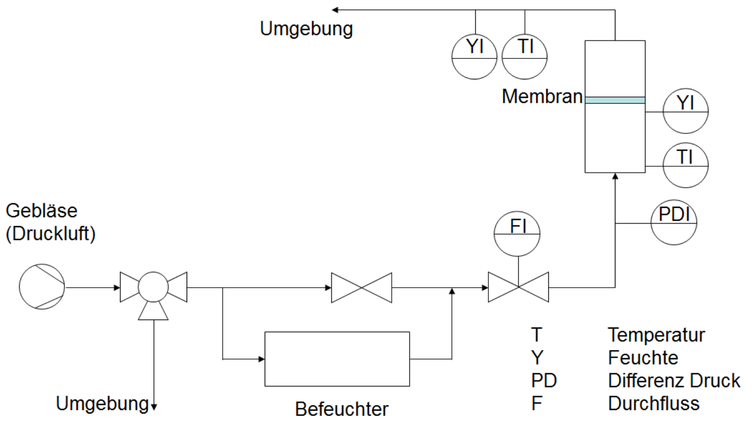


Figure 2: Function of the hydrohobic GORE membrane. (see www.gore.com)

Seperation of humidity

However, to ensure effective protection of electronic housings, gears, etc., all the removal of water is necessary.



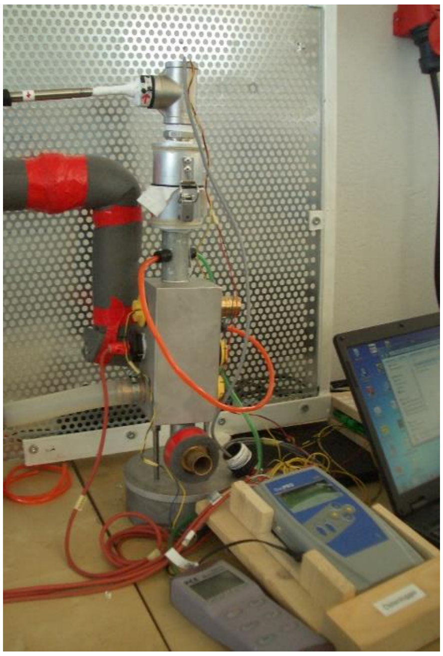


Abbildung 2: Versuchsaufbau zur Abscheidung von Luftfeuchtigkeit.

From this follows a consideration of the vapor deposition.

In the attempt to separate the humidity by ePTFE membrane, a poor success was achieved. The concentration of humidity is not relevant for the deposition. The degree of separation was comparable in the test at the humidities of 80% and 100%. The increase in the air volume flow also leads to a comparable change and to a slight improvement in the separation efficiency. This is due to the fact that the partial pressure at the input measurement increases and thereby leads to a larger difference between the output and input humidity. However, the deposition rate is about 2 - 8%, thus producing an air drying of 80% RH to 78 - 74% RH, or from 100% RH to 98 - 92% RH.

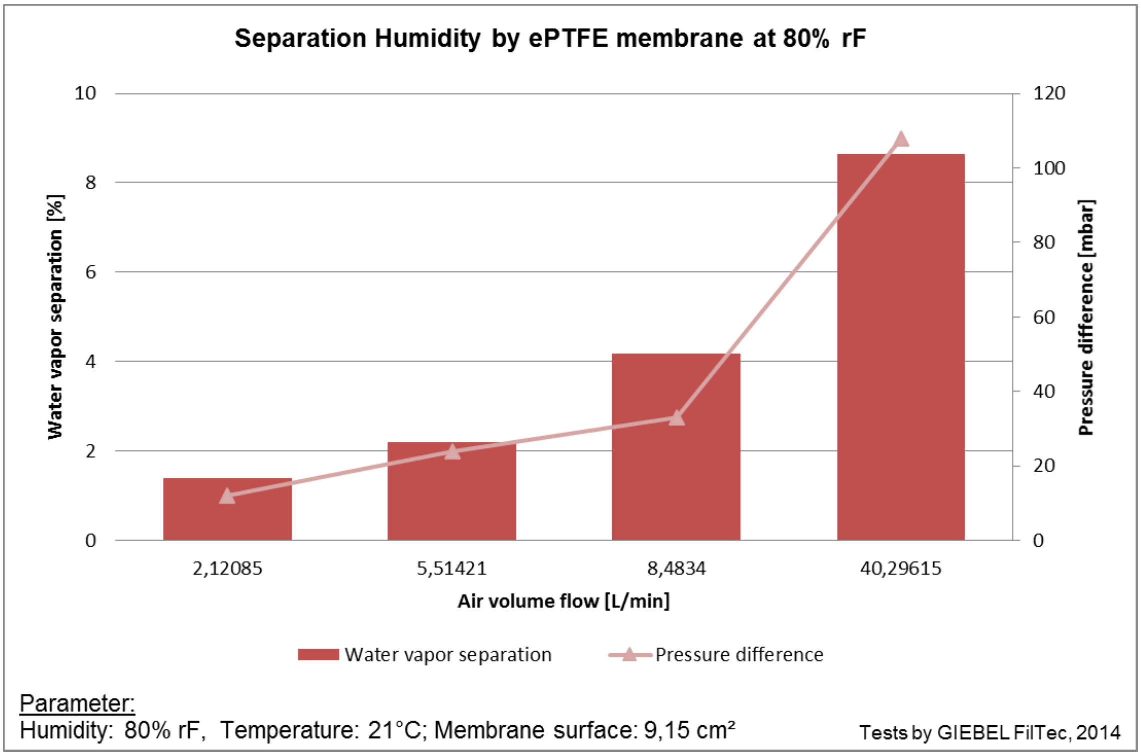


Figure 4: Water vapor deposition and pressure build up by ePTFE membrane at 80% RH.

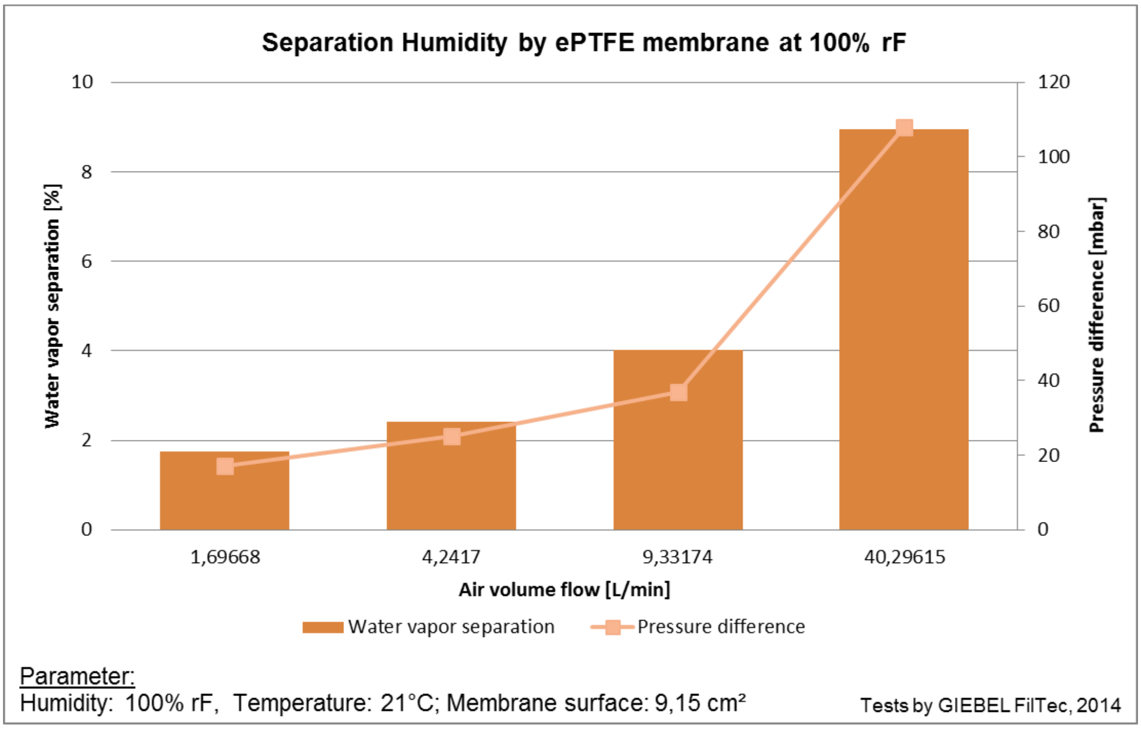


Figure 5: Water vapor deposition and pressure build-up by ePTFE membrane at 100% RH.

The poor separation of the water vapor molecules by a hydrophobic membrane is due to the pore size. The pores of the membrane for microfiltration are too large to retain single water molecules. In contrast to the most common membrane pores of 0.3-1.0 µm, the water molecule size is 0.26 nm. Thus, the pores are 1000-4000 times larger than the water vapor molecules of the atmospheric moisture.

Result

Because PTFE membranes are very microporous and highly hydrophobic, they hold back. At the same time, the membranes allow the water vapor and air to flow through. Due to this property, hydrophobic membranes are suitable for numerous applications, such. As waterproof textiles, microfiltration, packaging materials and pressure compensation elements, but not for ventilation drying.

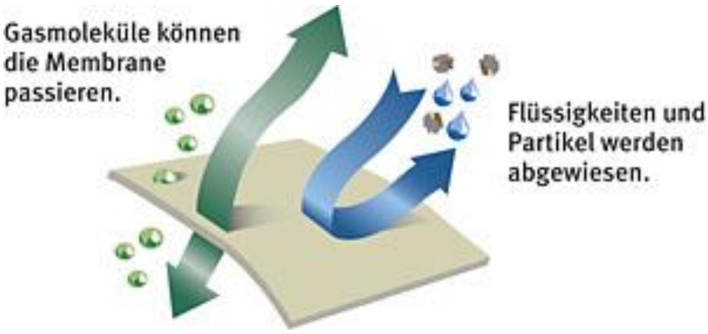


Figure 6: Illustration of the function of the GORE ePTFE membrane. (Www.gore.com)

GIEBEL FilTec, 14th May 2016