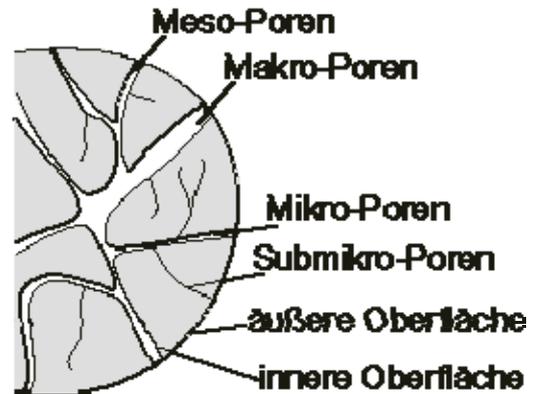




Fundamentals for the regeneration of silica gel

Silica gels have an amorphous, disordered microstructure and thus a broad pore size distribution.¹ Because of its polarity silica gels is a hydrophilic adsorbents, which is reflected in the affinity for dipolar molecules, such as water molecules. Because silica gel based on a physical adsorption, the water is bound by the not very strong van der Waals forces at the surface. The adsorbed water remains chemically unchanged and can be easily dissolved again.



Regeneration of Silica Gel

Regeneration of silica gel may be carried out by increasing the temperature, lowering the molar concentration of the adsorbate or lowering of the system pressure.² In practice, is applied as the most frequent regeneration method, the increase in temperature. During the desorption of water vapor from silica, the temperature must be above 100°C. We recommend a regeneration temperature of between 150°C and 175°C. However, it should be remembered that the color indicator is damaged on the silica gel at these temperatures. Therefore, a regeneration temperature for silica gel with color indicator specified by 120°C and should not exceed 140°C (see Abbildung 1).³

¹ L. Schnabel, „Experimentelle und numerische Untersuchung der Adsorptionskinetik von Wasser an Adsorbens-Metallverbundstrukturen,“ Berlin, 2009, S. 18.

² R. Goedecke, Fluidverfahrenstechnik: Grundlagen, Methodik, Technik, Praxis, Wiley-VCH, 2011.

³ D. Bathen und M. Breitenbach, Adsorptionstechnik, Springer, 2001, S. 141.

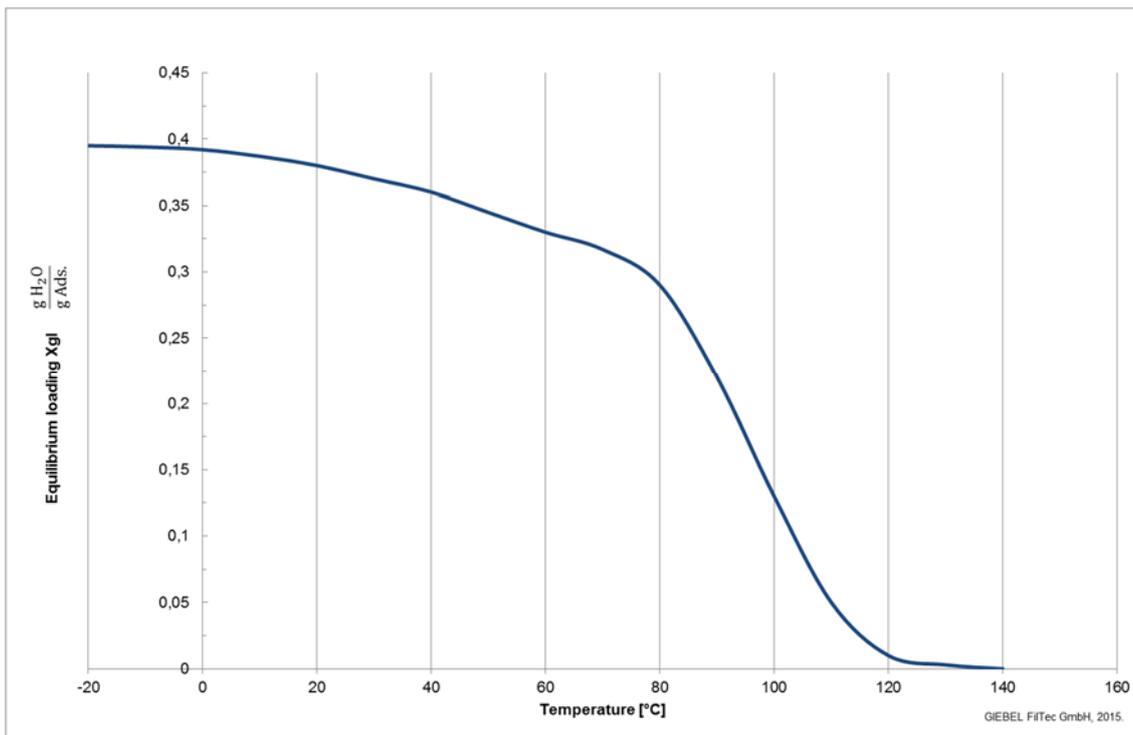


Abbildung 1: Equilibrium loading of silica gel as a function of temperature.

Color change of Silica gel

As color indicators different pH indicators are used, which belong to the organic dyes. These have the nature of weak acids or bases. The acid has a different color than the corresponding base. For silica gels, this means that the pH value will increase with increasing the water content, and changes color from orange to green or white. This process is reversible, so the original color can be adjusted by changing the pH value back, see Abbildung 2.



Abbildung 2: Color change by adsorption and regeneration.



Aging by Regeneration

If narrow porous, colorless silica is regenerated at a temperature of 150°C, the equilibrium concentration decreased after 100 cycles by about 20% and the half-diffusion coefficient by 32%, while the dry weight increases by about 2%. It is interesting that about 100 cycles with the decrease in the equilibrium concentration and the apparent diffusion coefficient, a limit is reached, which is changing not much after 500 cycles. This means that the pore structure is not significant change after the hundredth cycle by the thermal treatment (see Abbildung 3).⁴

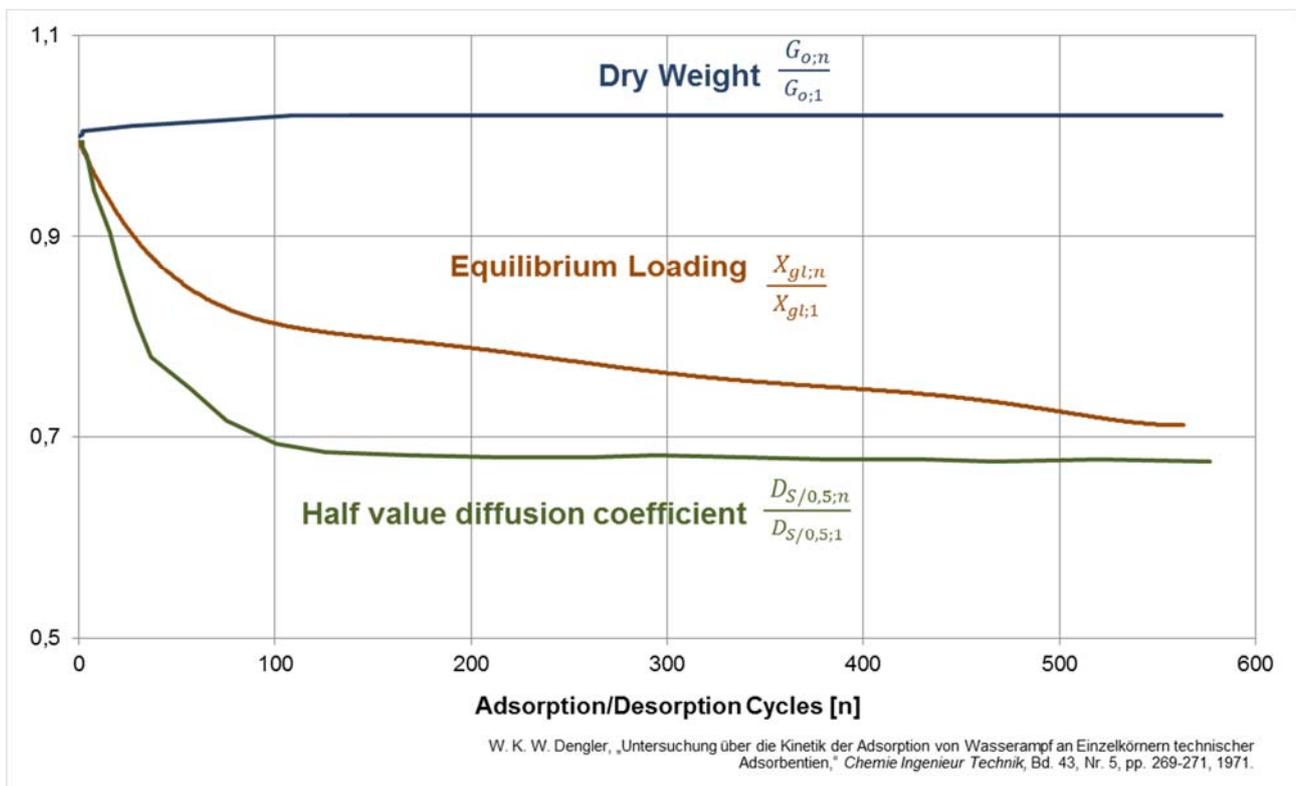


Abbildung 3: Equilibrium and half-diffusion coefficient as a function of regeneration cycles of silica gel.

⁴ W. K. W. Dengler, „Untersuchung über die Kinetik der Adsorption von Wasserampf an Einzelkörnern technische Adsorbentien,“ *Chemie Ingenieur Technik*, Bd. 43, Nr. 5, pp. 269-271, 1971., S. 271.



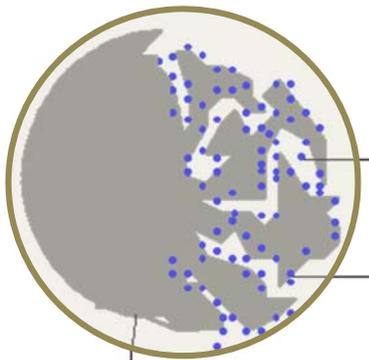
Influence of oil aerosoles

During operation of an absorber on hydraulic units or gears, there is outflowing oil mists. In GIEBEL Adsorber the oil particles are bound by the activated carbon. If an adsorber is used without charcoal or these does not change after adsorber saturation, the silica gel can be permanently damaged. The aerosols could stick to the outer surface of the silica gel



granules and close

the pores. There is no, or only a very limited water absorption possible.



For the regeneration of oil loaded silica gel the oil is brought deeper into the pores and is deposited there. Thus, the water absorption of the silica gel is in this area completely prevented.

Depending on the amount of the silica is this before, but especially after regeneration good to see. The oil loaded silica gel has at the beginning of a more brilliant color. After regeneration is "burnt oil" on the surface. A silica gel which is loaded with oil is irreversibly damaged and no longer suitable for further use (see Abbildung 4).

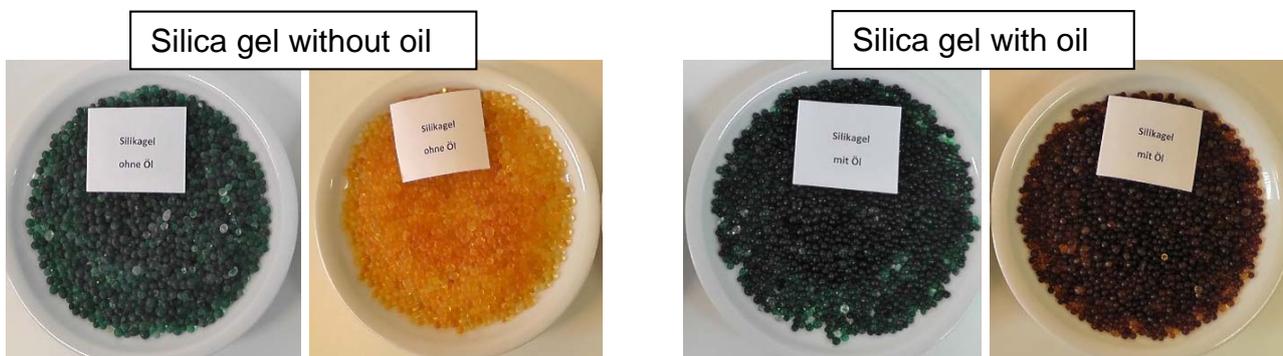


Abbildung 4: Silica gel before and after regeneration. Left without oil, right with oil.



Use of excessive temperatures

As mentioned above complete the regeneration of loaded silica gel occurs from about 120°C a completely. However, the regeneration would take place much faster in a temperature range of about 140-150°C, but represents a danger to the existing color indicator. In Abbildung 5, several regeneration cycles of silica gel at 250°C are shown. It is clearly seen that the color indicator is "burned" after the first regeneration. A damaged color indicator is irreversibly and not suitable for further use.



Abbildung 5: At 250 ° C regenerated Silica Gel Orange.

GIEBEL FilTec, 16.03.2016