

# Grenzflächenverfahrenstechnik II

*5. Vorlesung*

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# 5 Messung an Partikelsystemen

## 5.1 Filmflotation

### Kubische Partikel - Filmflotation

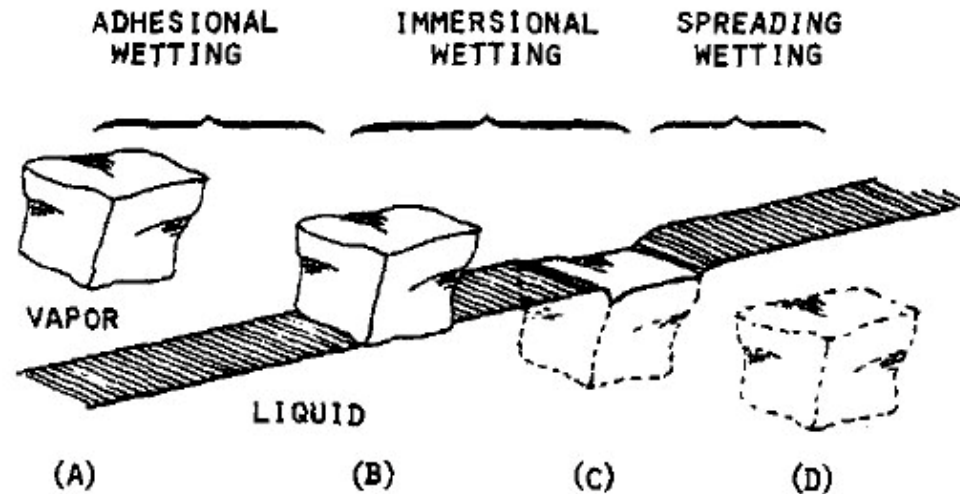


Fig. 1: Schematic of the film flotation process, starting with particles in the vapor phase (A). With a finite contact angle film flotation occurs (C), and immersion takes place (D) when the contact angle is zero.

# 5 Messung an Partikelsystemen

## 5.1 Filmflotation

### Ergebnis Filmflotation

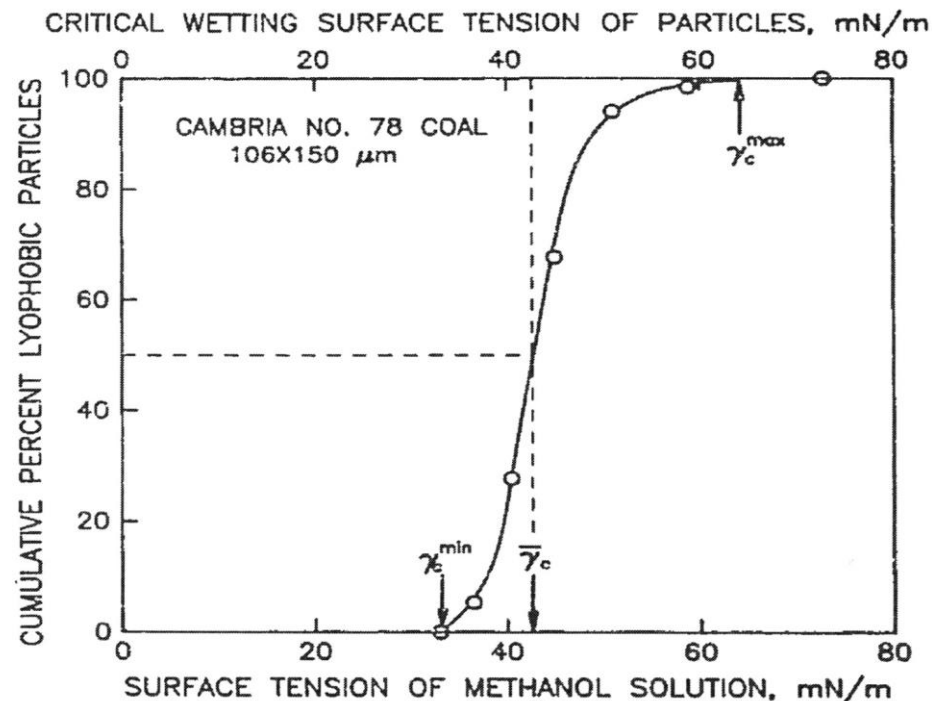


Fig. 1. The cumulative percentage of lyophobic (hydrophobic) Cambria No. 78 coal particles as a function of their wetting surface tension, as obtained from film flotation with aqueous methanol solutions.

# 5 Messung an Partikelsystemen

## 5.1 Filmflotation

### Verteilung der Benetzbarkeit

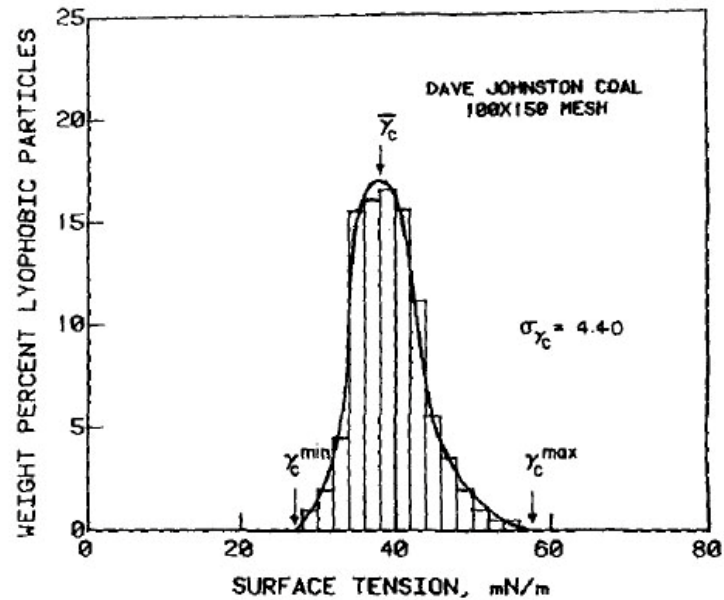


Fig. 5: Frequency histogram for the distribution of the wetting surface tension of 100 × 150 mesh Dave Johnston coal particles.

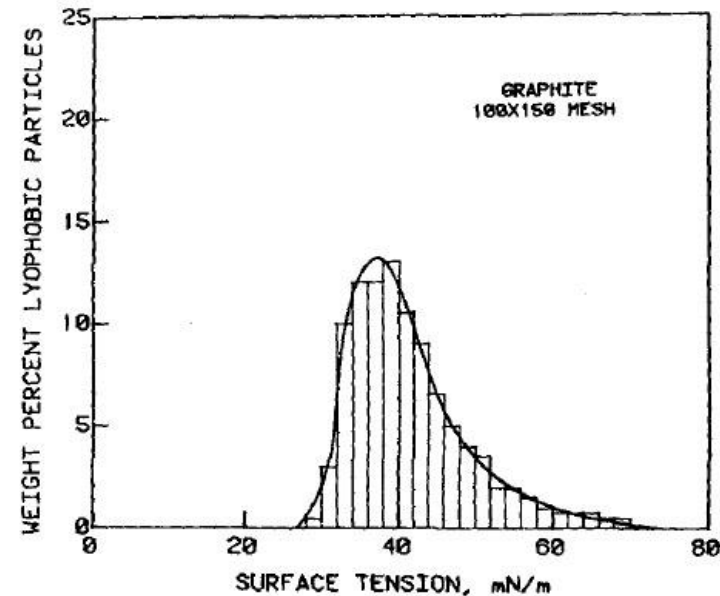


Fig. 6: Frequency histogram for the distribution of the wetting surface tension of 100 × 150 mesh graphite particles.

# 5 Messung an Partikelsystemen

## 5.1 Filmflotation

### Einfluss von Oberflächenoxidation von Kohle auf Benetzbarkeit

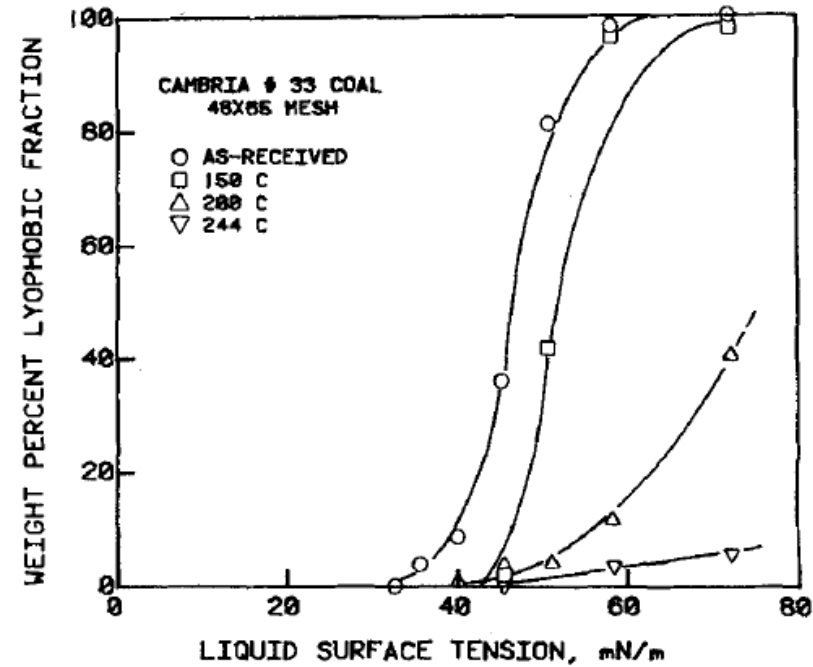
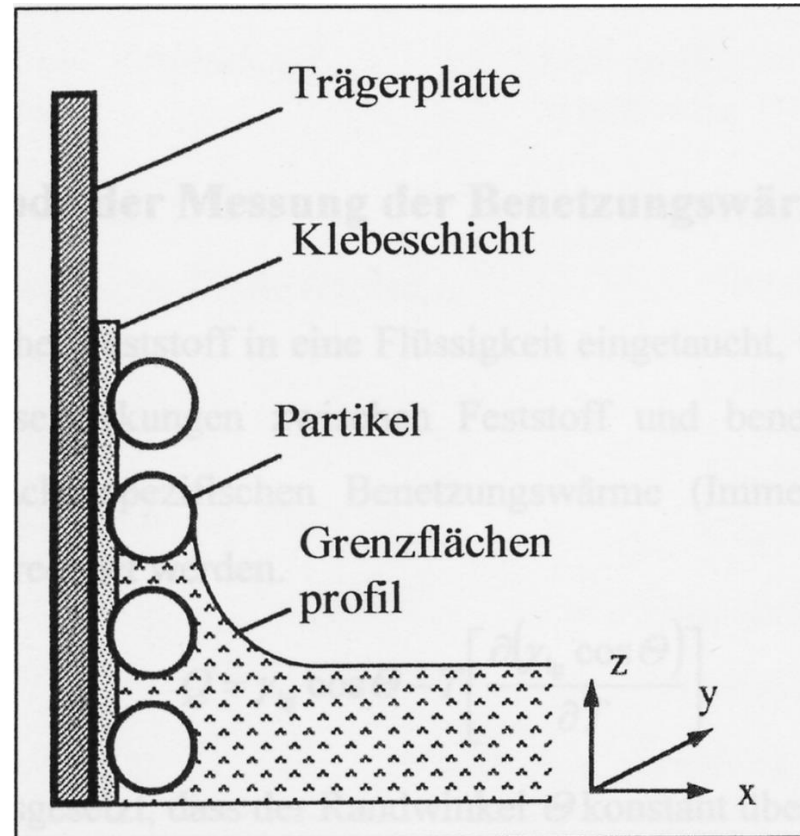


Fig. 11: The effect of oxidation on the film flotation of 48 × 65-mesh Cambria #33 particles.

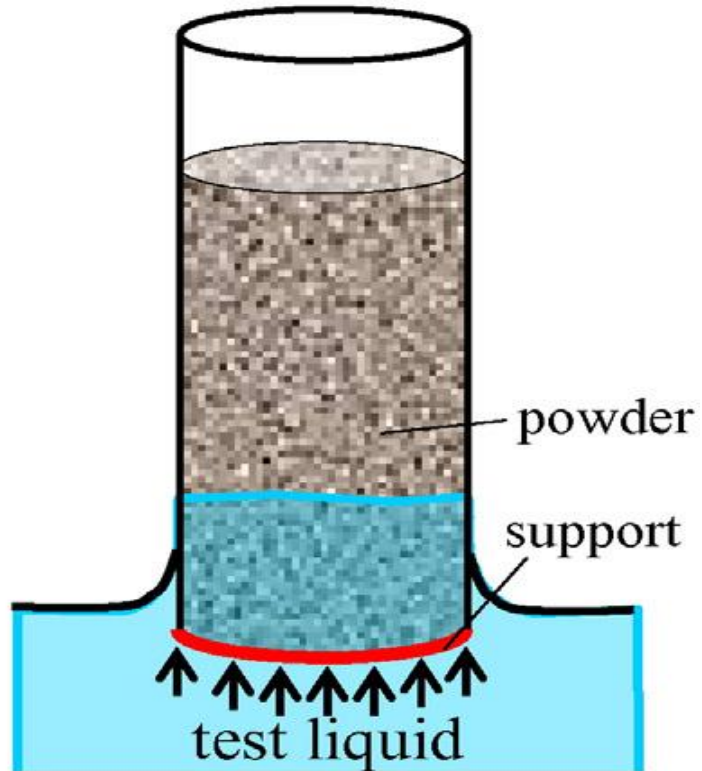
# 5 Messung an Partikelsystemen

## 5.2 Methode nach Bröckel und Löffler



# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett



$$dV = \frac{r^4 \Delta P \pi}{8 \eta h} dt$$

$$dV = r^2 \pi dh$$

Gesetz von Hagen Poiseuille

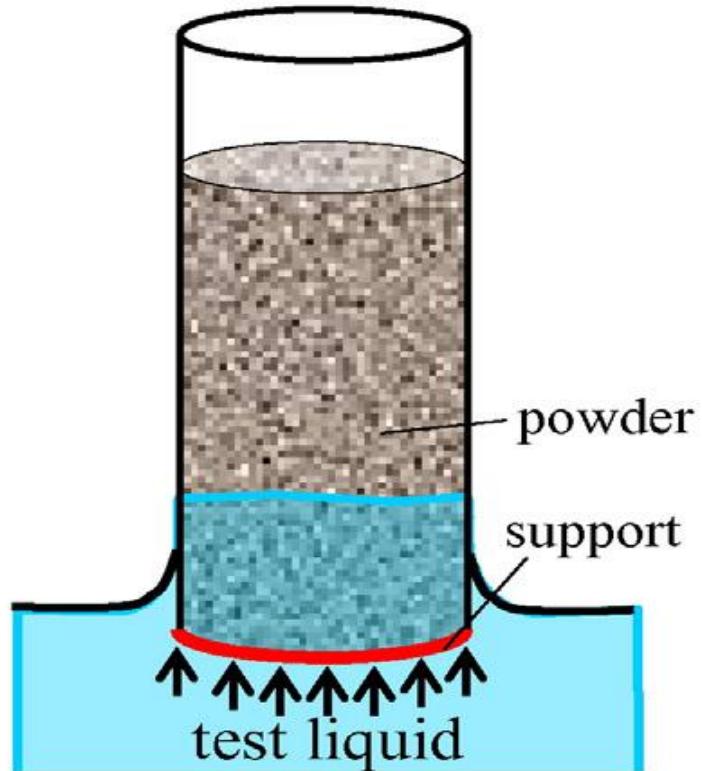
$$P_k = \frac{2\gamma}{r} \cos \theta$$

$$P_h = g\rho h$$

$$\Delta P = \frac{2\gamma}{r} \cos \theta - g\rho h$$

# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett



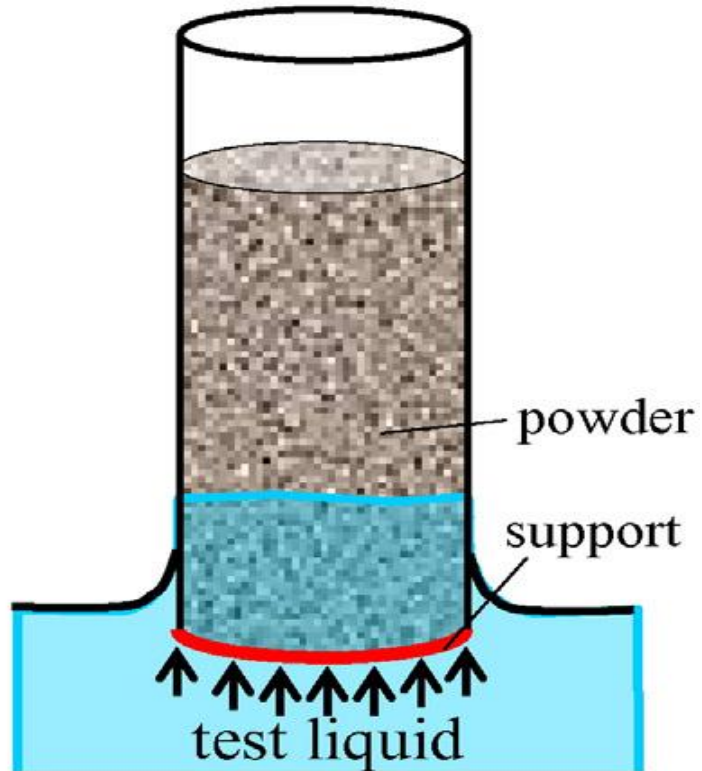
$$\frac{dh}{dt} = \frac{r^2}{8\eta h} \left( \frac{2\gamma}{r} \cos \theta - g\rho h \right)$$

$$h \frac{dh}{dt} = \frac{r\gamma \cos \theta}{4\eta}$$

$$h^2 = \frac{r\gamma \cos \theta}{2\eta} t$$

# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett



$$m = \pi R_k^2 h \rho \varepsilon$$

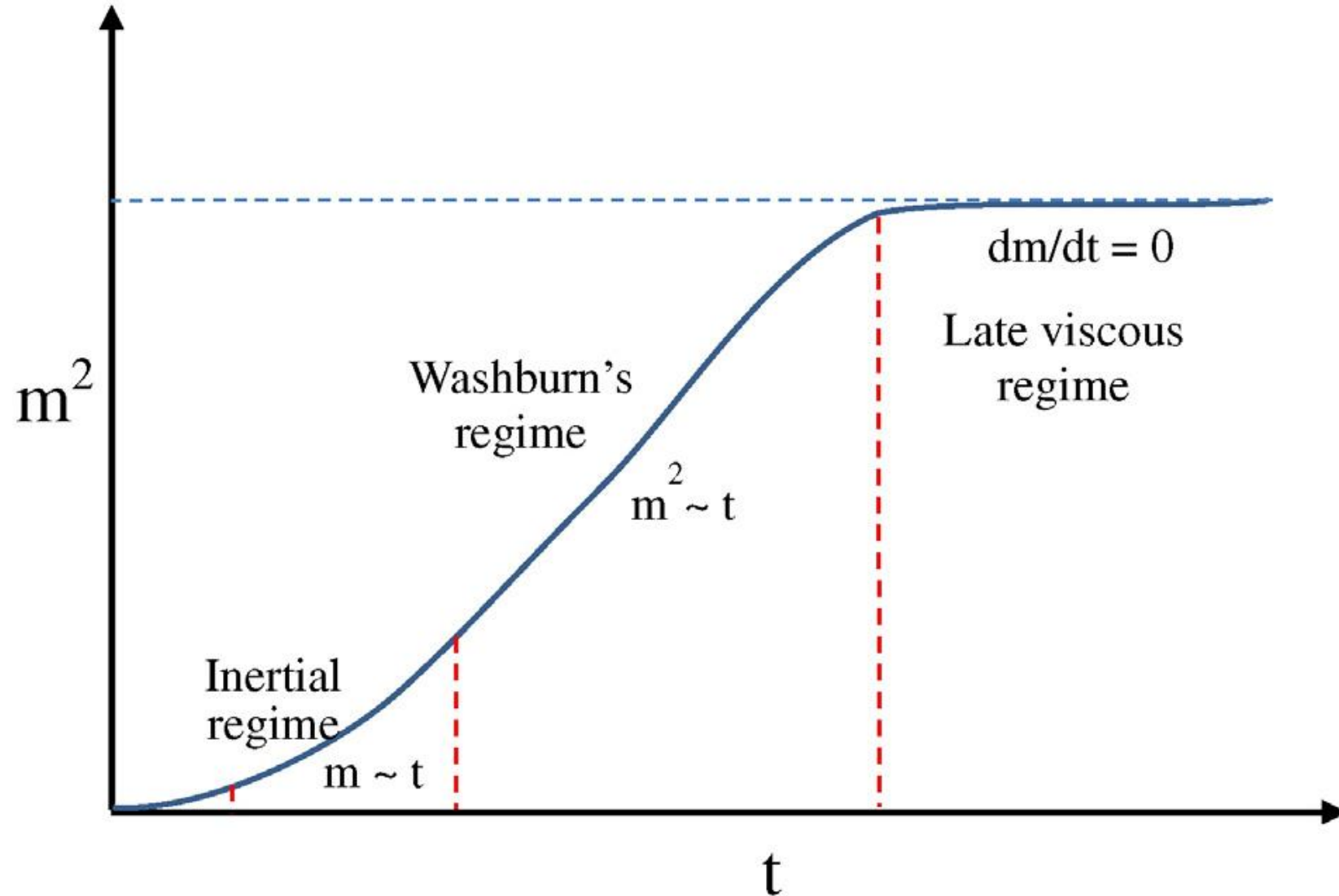
$$m^2 = \left[ \frac{r (\pi R_k^2)^2 \varepsilon^2}{2} \right] \frac{\rho^2 \gamma \cos \theta}{\eta} t$$

$$m^2 = \frac{C \rho^2 \gamma \cos \theta}{\eta} t$$

$$C = \frac{r (\pi R_k^2)^2 \varepsilon^2}{2}$$

# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett



# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett

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**Table 4**

The basic physical properties of liquids used as complete wetting liquids in the WCR experiments.

Liquid	Surface tension, $\gamma_{LV}$ (mN/m)	Viscosity, $\eta$ (mPa-s)	Density, $\rho$ (kg/m <sup>3</sup> ) $\times 10^{-3}$	Boiling point (°C) <sup>a</sup>	Vapor pressure at 20 °C (atm)
Pentane	16.5	0.240	0.626	36.06	0.5583
Hexane	19.1	0.326	0.660	68.73	0.1598
Cyclohexane <sup>a</sup>	24.6	0.980	0.778	80.70	0.1020
Heptane	20.5 <sup>b</sup>	0.411 <sup>c</sup>	0.684 <sup>c</sup>	98.38	0.0468
Octane	21.8	0.542	0.703	125.62	0.0139
Nonane <sup>a</sup>	22.4	0.670	0.718	150.47	0.0034
Decane	23.6	0.920	0.730	174.10	0.0009
Dodecane	27.6	1.508	0.749	216.30	~0
Hexadecane	27.2	3.340	0.773	286.50	~0
2,2,4-Trimethylpentane	18.8	0.504	0.692	99.24	0.0508
Methanol <sup>a</sup>	22.1	0.544	0.793	64.70	0.1281
Ethanol	22.4	1.074	0.789	78.29	0.0577
Toluene <sup>a</sup>	28.9	0.560	0.864	110.60	0.0287

The vapor pressure was estimated by using the Antoine's equation, and the Antoine's constants were obtained from either NIST or the website: <http://www.ee.umd.edu/~nsw/ench250/antoine.dat>

<sup>a</sup> Source: <http://pubchem.ncbi.nlm.nih.gov/>.

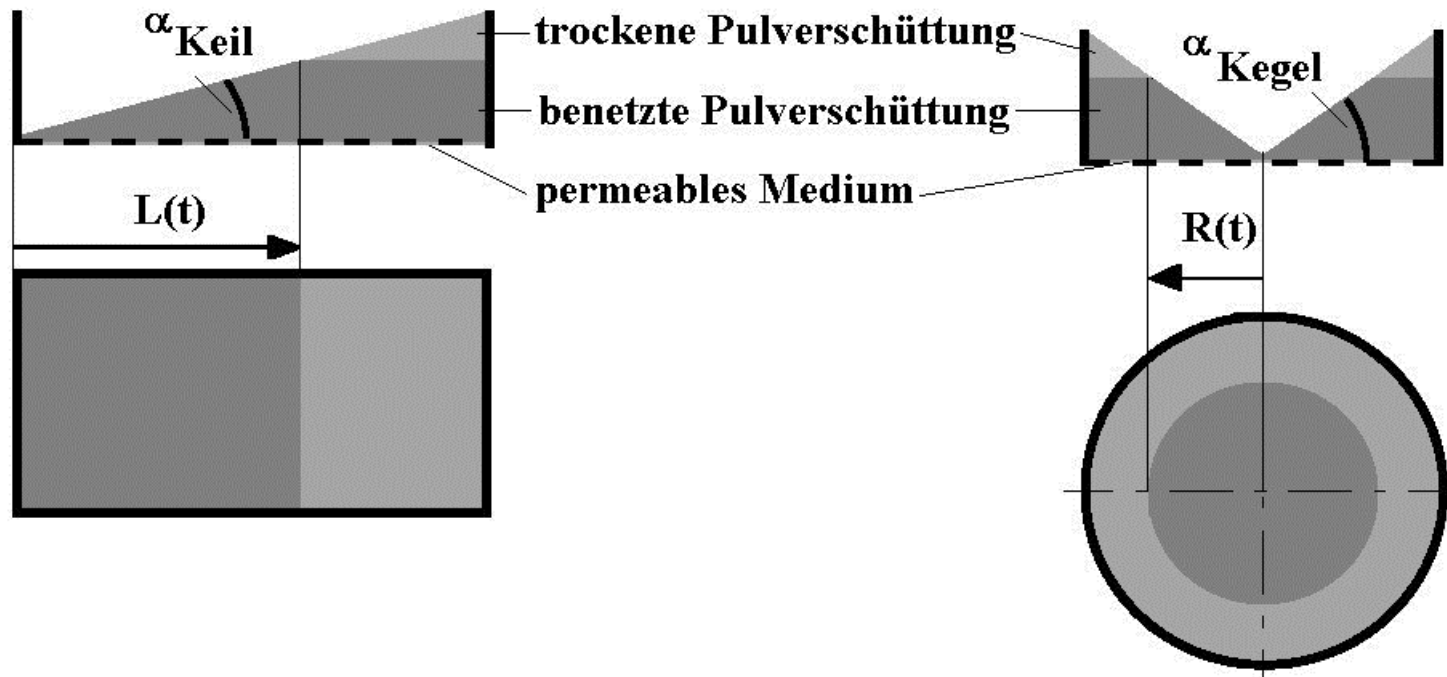
<sup>b</sup> Source: <http://pubs.acs.org/doi/pdf/10.1021/je025536%2B>.

<sup>c</sup> Source: NIST.

# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett

### Steighöhenmethode (Helmar Schubert)



# 5 Messung an Partikelsystemen

## 5.3 Flüssigkeitspenetration in Partikelbett

Fig. 7 Uncompressed (left) and compressed (right) test sample 1 during the wetting process

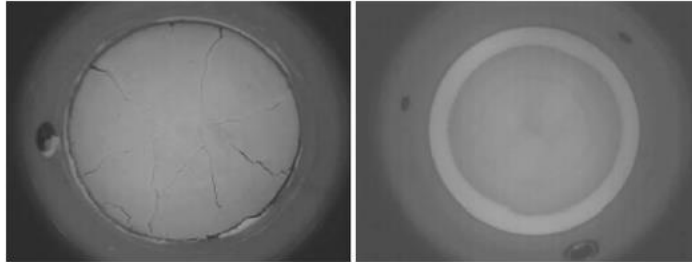
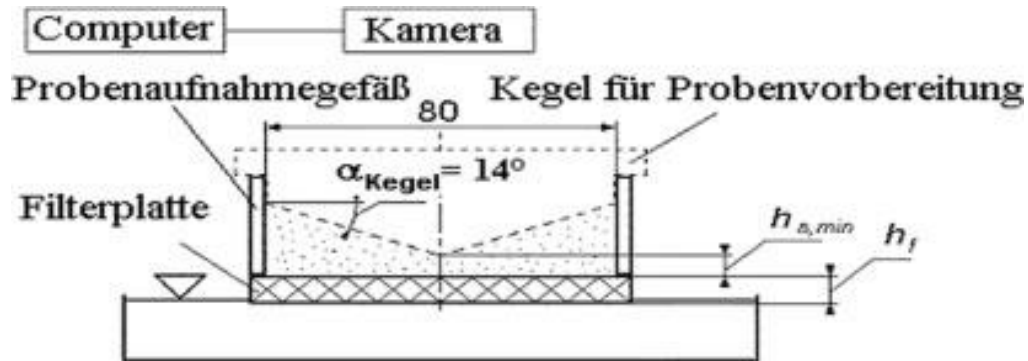
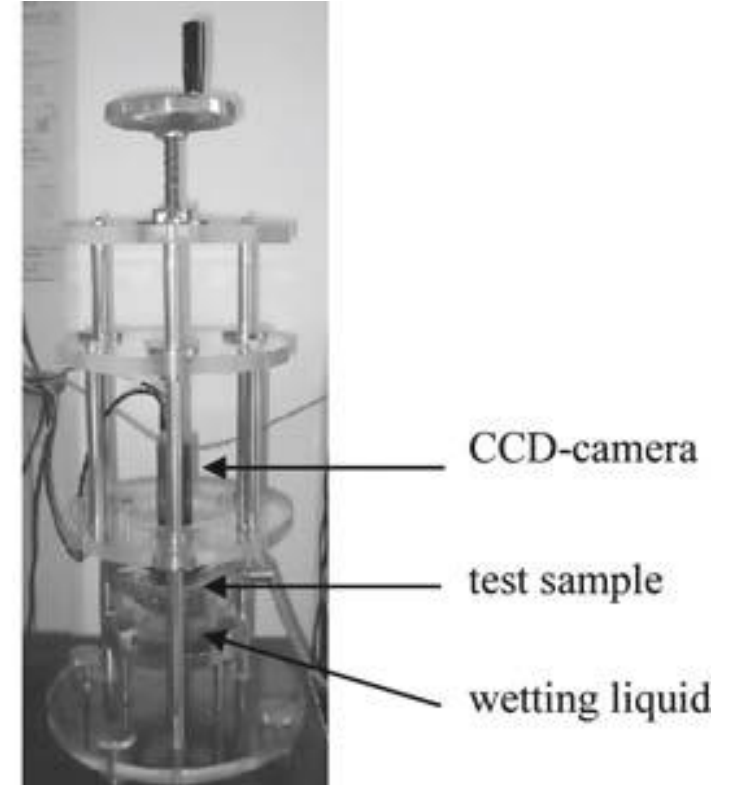
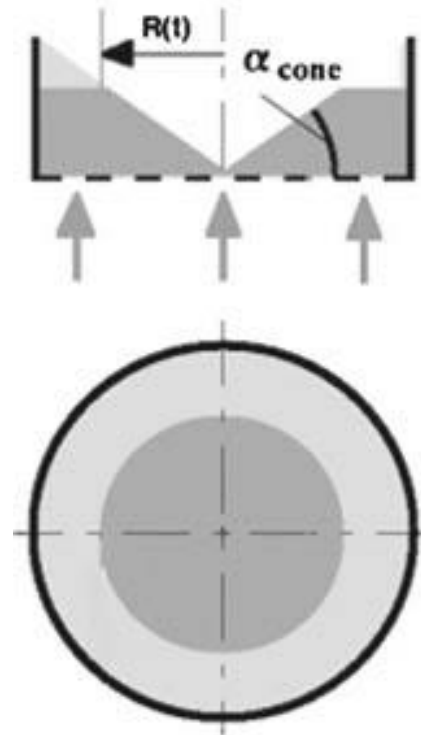
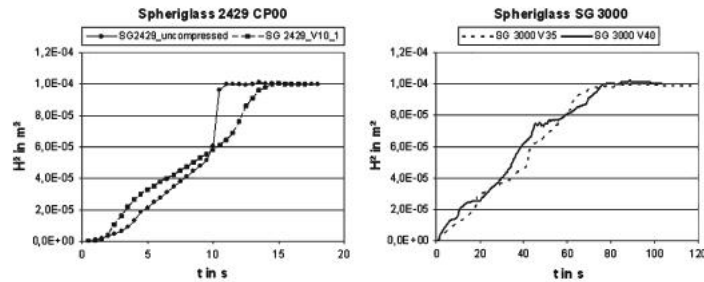
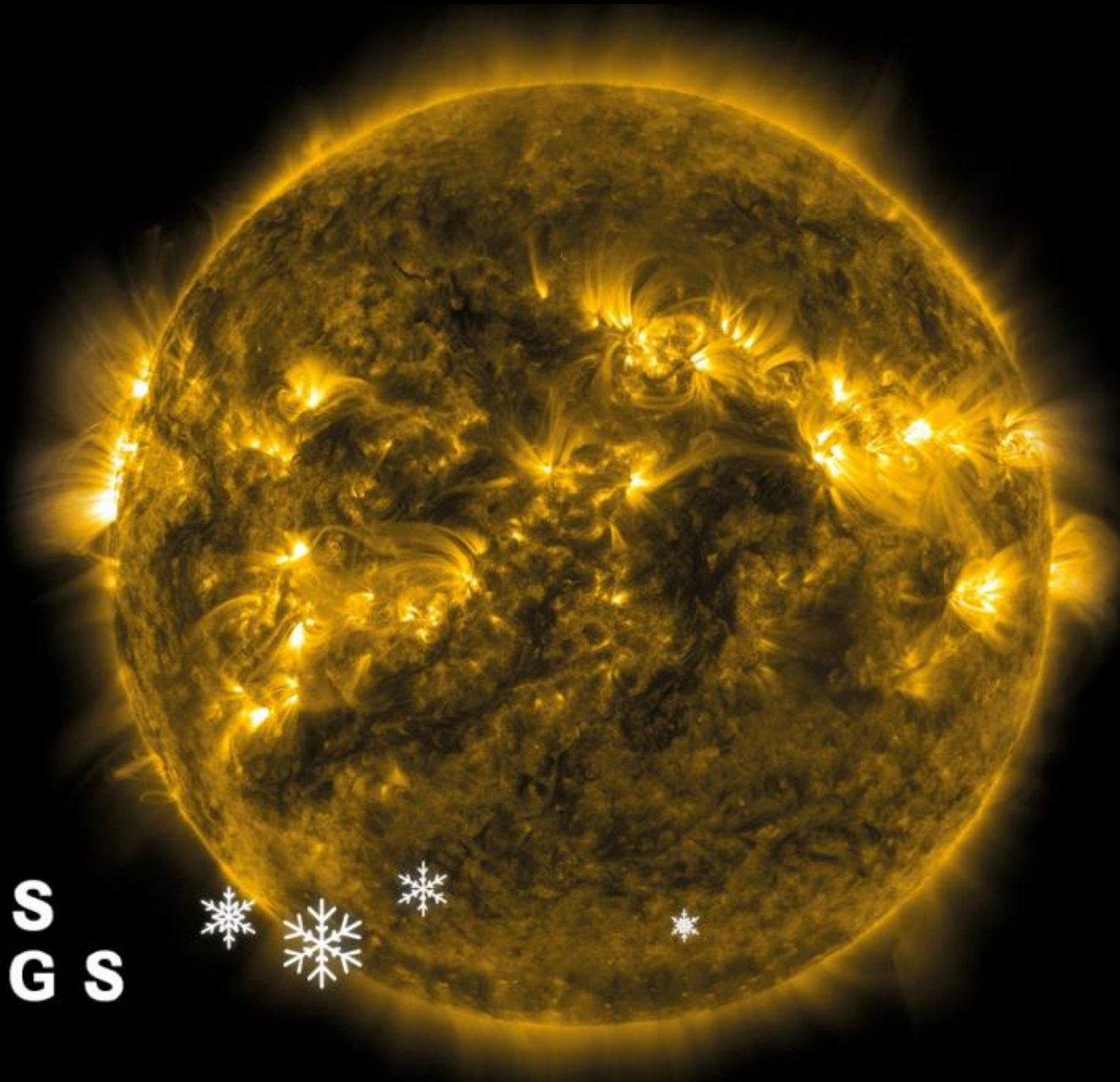


Fig. 8 Squared wetting height  $H^2$  versus time  $t$  for sample 1 and sample 2



**HZDR**

HELMHOLTZ ZENTRUM  
DRESDEN ROSSENDORF



**SEASON'S  
GREETINGS**

