

DIN 4904

*A good tool to compare properties
of sealing clays for water well
construction*



**stephan schmidt
gruppe**

Stephan Schmidt KG
Bahnhofstr. 92
65599 Langendernbach

Advanced Clay Minerals

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Matthias Schellhorn

Content

I. Stephan Schmidt KG - The company

II. DIN 4904

- ❖ Mandatory declarations
- ❖ Important quality features to distinguish between various pellet types of different producers

III. Conclusion



The company

- ❖ family-owned company since 1947
- ❖ 20 clay pits
- ❖ 1.6 million tons of clay per year
- ❖ >70 % export to more than 40 countries
- ❖ main business segment: ceramics
- ❖ “Advanced Clay Minerals” for special market applications





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Sealing clay according
to DIN 4904





DIN 4904: Importance

- ❖ **Definition of high quality standards** for successful and sustainable well construction with durable sealings
- ❖ **Comparability** of the quality of various sealing products
- ❖ Technical data sheets with helpful and **transparent product declarations**





DIN 4904 - minimum mandatory declaration

- ✓ Product name
- ✓ Reference to this standard
- ✓ Type of Product
- ✓ Dimensions in mm

- ✓ **Water content**
- ✓ **Bulk density in g/cm^3**
- ✓ Percentage of oversize / undersize particles by mass in %

- ✓ **Swelling pressure, indicating test duration, in N/mm^2**
- ✓ Radiation activity API
- ✓ **Coefficient of hydraulic conductivity in m/s**
- ✓ Sinking velocity in m/min
- ✓ **Structural stability**
 - 1 during sinking as percentage by mass in %
 - 2a installed as percentage by mass in %
 - 2b penetration resistance in N/mm^2

Current aim: including drinking water hygiene (new trogeluate method) into the DIN 4904





Most requested quality features for sealings
as part of construction projects:

- ❖ **Low hydraulic conductivity**
- ❖ **High swelling volume**

*...How important are these parameters and are they
suitable to distinguish between the quality of
different sealing products?*



Very important for the sealing quality



Material	k [m/s]
Compactonit® 10/200	1 x 10 ⁻¹¹
Compactonit® 10/80	4 x 10 ⁻¹¹
Quellon® HD (with heavy mineral)	2 x 10 ⁻¹¹
Quellon® WP	1 x 10 ⁻¹¹
Compactonit® Typ S	5 x 10 ⁻¹¹
Compactonit® TT 3/8 (granule)	Not measured
Competitor 1	6 x 10 ⁻¹¹
Competitor 2 (with heavy mineral)	5 x 10 ⁻¹¹
Competitor 3	3 x 10 ⁻¹¹
Competitor 4 (granule)	6 x 10 ⁻¹¹

*Similarly low k values of the sealing products
 → no differences in quality*

Coefficient of hydraulic conductivity k of various sealing products





Dry filling levels and swelling volumes at different weights and in different measuring vessels

Not comparable and less relevant

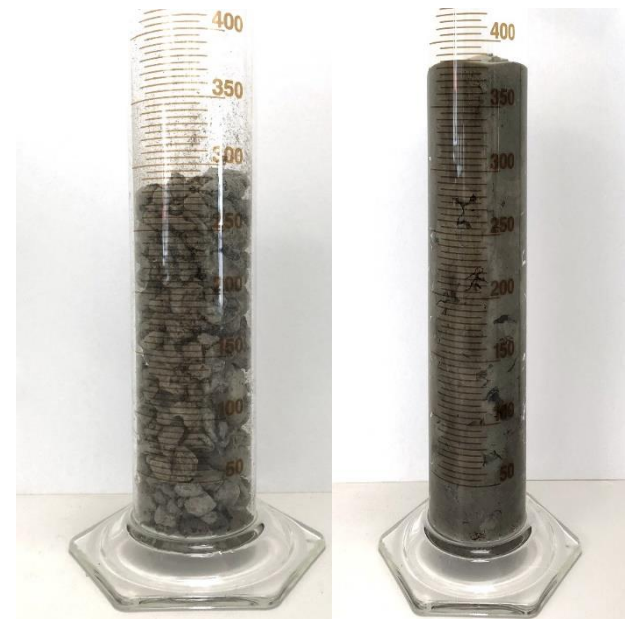
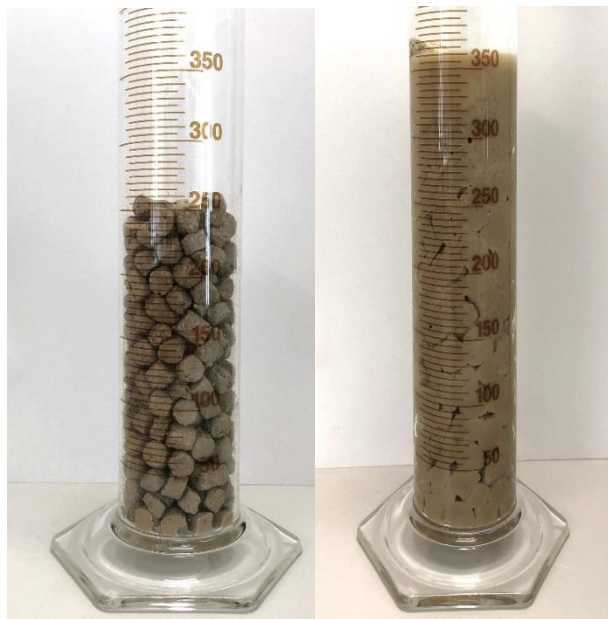
	Compactonit® Typ S	Competitor 4
500 ml Beaker, 100 g		
- dry	100 ml	120 ml
- swollen	190 ml	260 ml
- increase in volume	190 %	217 %
500 ml Cylinder, 150 g		
- dry	140 ml	160 ml
- swollen	200 ml	240 ml
- increase in volume	143 %	150 %
500 ml Cylinder, 300 g		
- dry	260 ml	290 ml
- swollen	360 ml	385 ml
- increase in volume	138 %	133 %

Swelling volumes depend on vessel geometry, initial sample weight and sample preparation!

The swelling volume is diminished for high initial weights filled in narrow vessels → shell friction!

...Boreholes, annular spaces





Compactonit® Typ S

Competitor 4

Comparison of swelling volumes
at 300 g in a cylinder of
500 ml capacity





You never have higher densities than bulk densities of the products!

Material	Bulk density [g/L]	Dry density [g/L]
Compactonit® 10/200	1.17	1.00
Compactonit® 10/80	1.20	1.04
Quellon® HD (with heavy mineral)	1.35	1.12
Quellon® WP	1.17	1.00
Compactonit® Typ S	1.25	1.07
Compactonit® TT 3/8 (granule)	1.18	1.00
Competitor 1	1.05	0.85
Competitor 2 (with heavy mineral)	1.25	1.02
Competitor 3	1.07	0.86
Competitor 4 (granule)	1.08	0.98

The higher the dry density, the higher the swelling pressure!
→ Advantage of vacuum extrusion!

Pellet density





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Oedometer measurement cell of Ruhruniversität Bochum



Swelling pressure





Swelling pressure ≠
swelling volume

Material	Equilibrium swelling pressure [kPa]	Category
Compactonit® 10/200	40	3
Compactonit® 10/80	20	3
Quellon® HD (with heavy mineral)	25	3
Quellon® WP	40	3
Compactonit® Typ S	5	2
Compactonit® TT 3/8 (granule)	0	1
Competitor 1	0	1
Competitor 2 (with heavy mineral)	0	1
Competitor 3	30	3
Competitor 4 (granule)	5	2

The swelling pressure is the important factor regarding a stable connection of the sealing to the wall.

Very important for the sealing quality

Swelling pressure





Very important for
the sealing quality

Material	Loss of mass [%]
Compactonit® 10/200	<10
Compactonit® 10/80	<10
Quellon® HD (with heavy mineral)	<10
Quellon® WP	<10
Compactonit® Typ S	<10
Compactonit® TT 3/8 (granule)	>10
Competitor 1	>>50
Competitor 2 (with heavy mineral)	>>50
Competitor 3	<10
Competitor 4 (granule)	>10



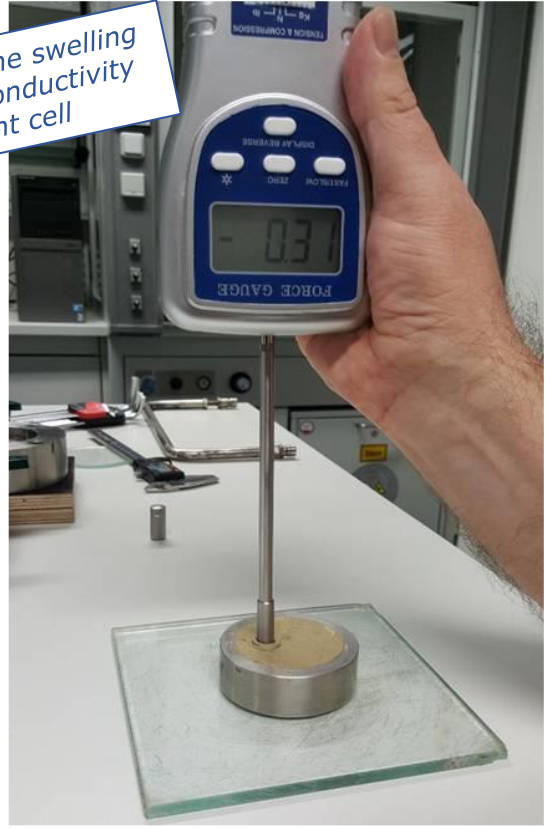
Structural stability 2a





...after determination of the swelling pressure and hydraulic conductivity in the same measurement cell

Determination of the **penetration resistance** using a pocket penetrometer



Structural stability 2b





Very important for the sealing quality

Material	Penetration resistance = Force [kPa]
Compactonit® 10/200	310
Compactonit® 10/80	60
Quellon® HD (with heavy mineral)	150
Quellon® WP	310
Compactonit® Typ S	40
Compactonit® TT 3/8 (granule)	Not measured
Competitor 1	30
Competitor 2 (with heavy mineral)	80
Competitor 3	140
Competitor 4 (granule)	Not measurable

~ measure of the longterm stability of the sealing in swollen state

Structural stability 2b





- ❖ **High importance** of DIN 4904 (and KIWA BRL K265) **for quality standards** in well construction
- ❖ **DIN 4904 enables the comparison** of various sealing products:
 - ❖ Important yet **no quality difference: hydraulic conductivity**
 - ❖ **Less relevant** quality feature: **swelling volume**
 - ❖ **Relevant** quality features & **quality differences: densities, swelling pressures** and **structural stabilities** 1-2a-2b
- ❖ Some companies still do not declare their sealing products following DIN 4904 → it needs to get more popular and accepted

DIN 4904: Conclusion



Thank you!

Glückauf!



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