



Ruma Products BV. HOLLAND
Technical Product Report

Swelling Seal Elastomers and their use in repair of water Wells

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Summary

This report highlights the work done on testing and development of the swelling seal system (QRS) supplied to Grondboorbedrijf Haitjema, Dedemsvaart-NL. The concept and project engineering is coordinated by Scheper.Co – engineering & consulting.



Ruma Products BV. Hoogeveen Holland.

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1. Background Information

1.1. What are swelling seals

Swelling seals are seals produced from elastomers that swell when brought into contact with various motive fluids. These fluids can be almost endless in their variety however the elastomer has to be designed to be sensitive to that fluid. Swelling Elastomers are not new and have been known since the elastomer itself are developed. Swelling of the elastomer was always seen as a potential problem and often this was actually a major problem. In industries such as those in drink water supply pipes it is a requirement that the elastomer does not swell when in contact with the water, this is still an important characteristic as one of those side effects of the elastomer with the water.

The use of swelling seals has found some prominence in the last decades within Oil and gas wells, where it has proven useful in the creation of compartments in long open-hole liner systems as well as for fracturing formations. This application was simply the result of their being easy to use. Unlike mechanical seals used in wells, there is no setting mechanism required. You run them into the well and they will swell if the fluid and the elastomer are compatible. Nothing else is needed. In mechanical seals, the engineering has to be done per seal type and is a considerable engineering design workload. In swelling seals the chemical engineering required to design the elastomeric compound and the bonding requirements is in its own right a considerable engineering workload, however, once it has been done the rest is comparatively easy. You can alter the dimensions of the seal at will as it has little engineering impact upon the final product. This has been the reason for its substantive use in the fracturing of wells. Where previously a number of mechanical seals are applied in fractured wells, the mechanical actuation of these seals was complex and there were also many limitations on what could be used and done. By using swelling seals there were effectively very few limitations.

1.2. Swelling seals

How do they work? Whilst there are a number of different seals they all work basically by the creation of a diffusion gradient between the elastomer and the motive fluid. This diffusion gradient effectively pulls the motive fluid INTO the elastomer. Because the elastomer is "elastic" this results in the seal swelling. It is worth mentioning that, this diffusion gradient exists in many everyday things. Biscuits have them too, which is why they become soft and crumbly if not sealed well in a tin. If these biscuits were flexible they would also swell. It is also why boiled sweets become soft and sticky. They all have diffusion gradients and this is often towards the water as the motive fluid or in the case of the last few examples water vapour in the air we breathe.

2. Water Swelling Seals as a repair for Water Wells

In the oil world repairing of wells using swelling seals is now a pretty common event and in general use world-wide either as straddles or on expandable pipes for shutting off zones.

The same type of work can also be done on water wells where damage has occurred in the filter system in the well. A swelling elastomer can be used to bridge out or form a bridge to bridge out filter failure zones. Because of the low pressures involved, It is a relatively simple operation requiring now secondary manipulation and it requires only a swelling seal to swell and shut off the damage.

2.1. Case Details

Location	= Arnhem – Netherlands
Client	= Tennet (Duiventil)
Number	= 3 wells – 6 QRS systems
Date	= October 2016
Certain aquifer	= 6.2 mg/l
Temperatures	= 12 °C

Bron K1 = Ø 290 mm – 200m depth

QRS 1	= leaky connection ± 72 m-mv (1m)
QRS 2	= filter damage ± 146.4 – 148 m-mv (3m)
Bron W1	= Ø 290 mm – 200m depth
QRS 3+4+5	= W1 leaky connections ± 51.9 – 82.9 m-mv (1m+2m+2m)
Bron W2	= Ø 290 mm – 200m depth
QRS 6	= W1 leaky connection ± 76 m-mv (1m)

2.2. QRS details

Stainless Steel Tubes:

Dimensions: 256 x 3 mm [Van Leeuwen/gel. Buis EN 10217-7 TC1 - DIN 2463 1.4301].

Seal (standard):

Dimensions: Rd 256 x Rd 280 mm

Seal length: 425 mm

Running Guides [RG] 2x 50 mm

Spacing between RG en Seal 2x 10 mm

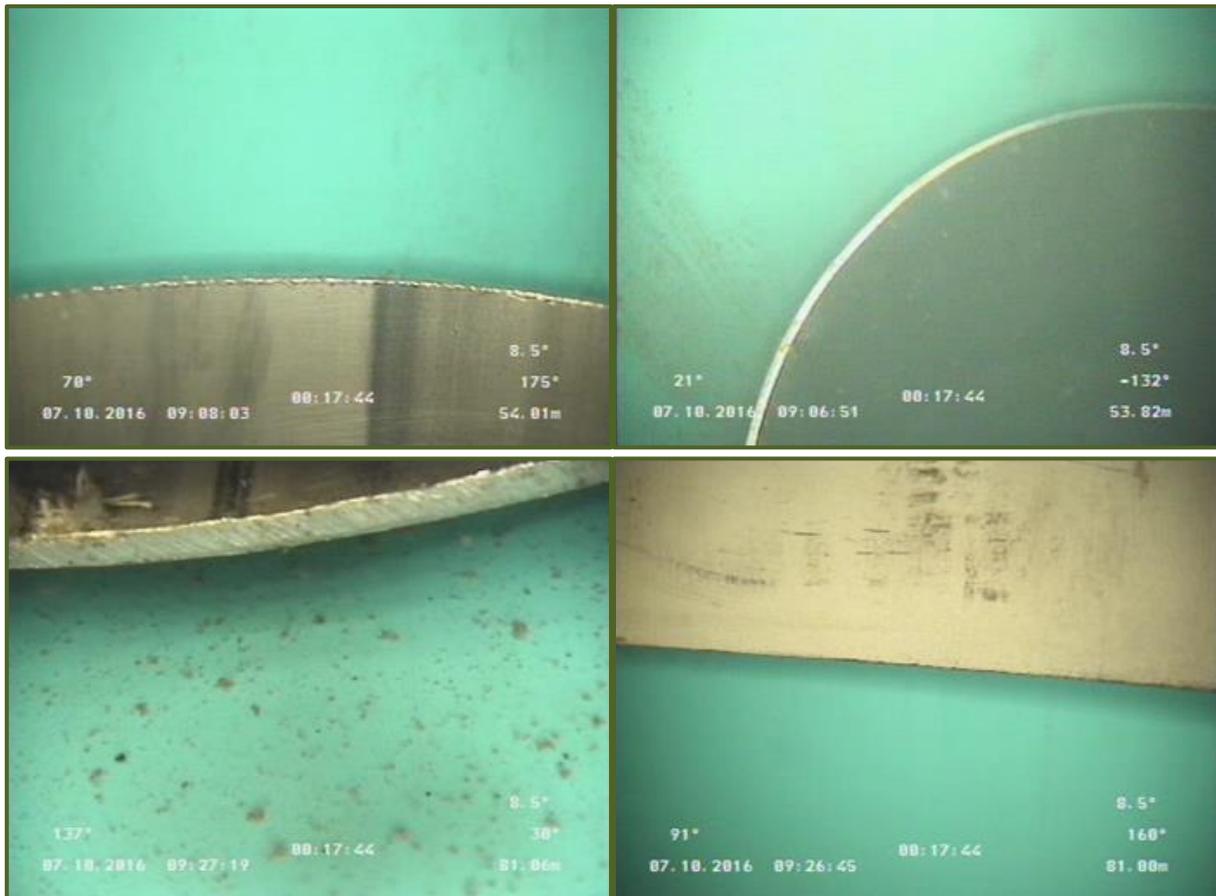
Handling space 40 mm

Compound:

Oblique water swelling [blue]

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2.3. Installation Details (completed and sealed)



Above we see the installed QRS systems in Bron W1

2.4. Conclusion

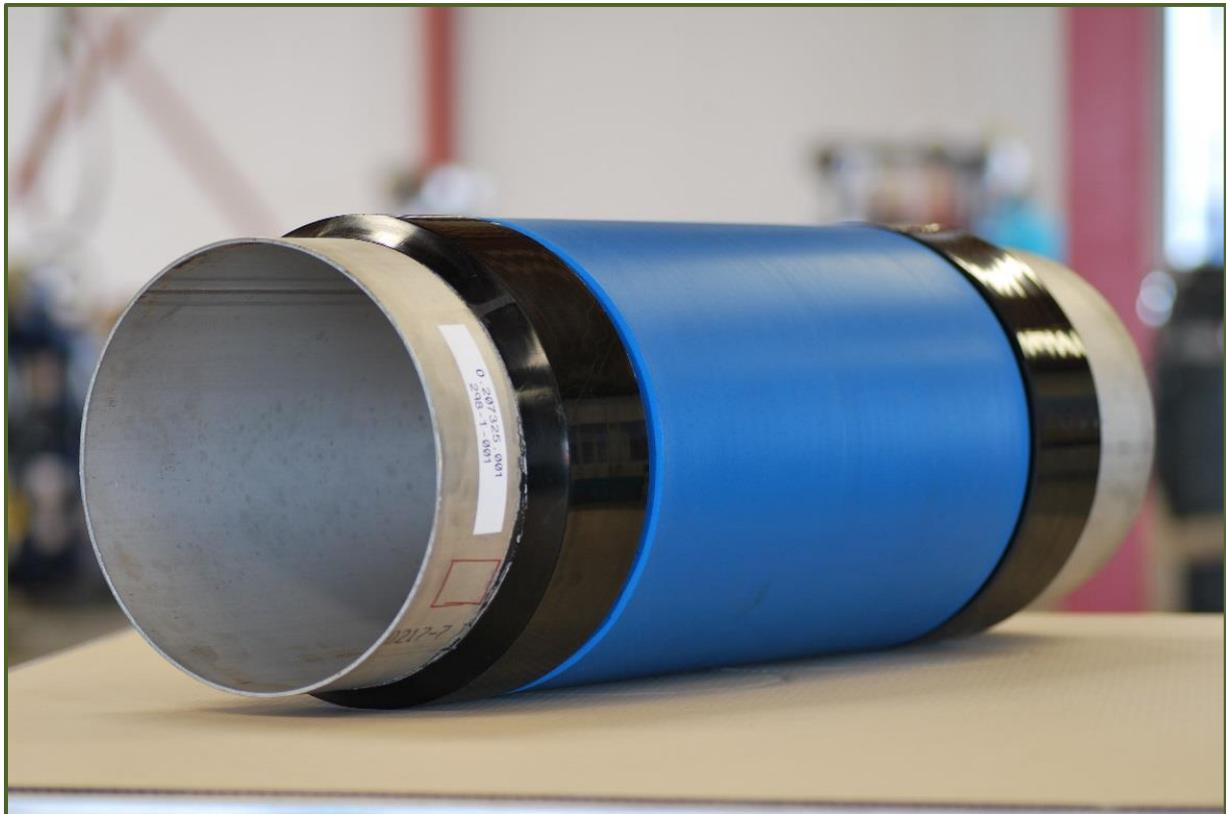
Drilling and service companies observe an increasing trend for the repair and maintenance of KWO systems. This is also due to the increasing number of systems. After a pilot with the QRS systems at the described wells, we experienced a suitable system for repairing KWO systems. The employees of Haitjema are excited about the product and its possibilities. After the installation (12 months later) we experience a proper manner for repair and the problems of leakages and polluted zones are solved. We notice that the pump results (after repair) remained the same and did not show a decreasing interval. It's also a good technique for wells that knows redox contamination by poorly bonded joints and/or wells that are damaged in the centre of the filter or riser. The point of attention is the spacing between tool and well. Also, the precisely needed recipe for the compound is not always practical. (mr. Bas van Aggelen & Marcel Lamberink – Grondboorbedrijf Haitjema - 2017)

In 2017 we've made some last improvements. The QRS has now 1 uniform compound to repair water wells with temp. of 7 – 24 °C and water qualities between 150 – 20000 mg CL-/l, up to depths of 500 m and knows a larger bridging. (Scheper.Co – Oblique)

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2.5. QRS Product

Below is the 1-meter QRS system ready for delivery.



Below the production details of the pilot systems.

OBLIQUE <small>advancing sealing solutions</small> Document Name: Data Release Sheet Q-SEAL Document No: E100-20 Version: 1	Ruma Products-SO 298-1-001 RP Article-No 0.207325.001 Customer Article-No Customer Haitjema Grandboorbedrijf PO-No 11568/SB20161303/BAN Quantity 3 Comments Colour tone variations do not affect the working of the swell. Impressions left by the manufacturing wrapping tape in the elastomer do not affect the functioning of this product.	Seal  Product Name: Q-Seal 256 x 280 x 425mm W-04	Visual Inspection Rubber inspection <input checked="" type="checkbox"/> Thread protectors <input type="checkbox"/> Threads <input type="checkbox"/>																																														
	Product Release Date 27/8/16 Signature 	APPROVED BY OBLIQUE QUALITY CONTROL	All measurements start at Box end ! <table border="1"> <thead> <tr> <th></th> <th>mm (min.)</th> <th>inch (min.)</th> <th>mm (max.)</th> <th>inch (max.)</th> </tr> </thead> <tbody> <tr> <td>Pipe OD</td> <td>253</td> <td>9,96</td> <td>255</td> <td></td> </tr> <tr> <td>Guide ring reference</td> <td>405-70</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Guide ring OD</td> <td>280</td> <td>11,02</td> <td>283</td> <td>11,14</td> </tr> <tr> <td>Seal OD</td> <td>280</td> <td>11,02</td> <td>282</td> <td>11,10</td> </tr> <tr> <td>Seal length</td> <td>420</td> <td>16,54</td> <td>430</td> <td>16,93</td> </tr> <tr> <td>Number of seals</td> <td>1</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Compound reference</td> <td>W-04</td> <td></td> <td>Blue</td> <td></td> </tr> <tr> <td>Hardness (Shore A)</td> <td>75</td> <td></td> <td>85</td> <td></td> </tr> </tbody> </table>		mm (min.)	inch (min.)	mm (max.)	inch (max.)	Pipe OD	253	9,96	255		Guide ring reference	405-70				Guide ring OD	280	11,02	283	11,14	Seal OD	280	11,02	282	11,10	Seal length	420	16,54	430	16,93	Number of seals	1				Compound reference	W-04		Blue		Hardness (Shore A)	75		85		
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Ruma Products Lindberghstraat 49 7903 BM Hoogeveen Nederland Tel: 0031 528 260 160 E-mail: sales@oblique.eu Web: www.oblique.eu																																																	
Product serial No	Unit	Left	Right	Left	Middle	Right	Seal	Hardness Shore (A)	Batch-No	Vulcanization date	Operator	Comments																																					
O.207325.001/ 298-1-001	mm Inch	281,0 11,06	281,7 11,09	280,0 11,02	280,4 11,04	280,0 11,02	422 16,61	85	13-20	23-08-16	WM/HL																																						
O.207325.001/ 298-1-002	mm Inch	281,3 11,07	282,0 11,10	280,4 11,04	281,0 11,06	281,0 11,06	425 16,73	85	13-20	26-08-16	WM/HL																																						
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3. Technical Details

The wells in general are low-temperature, low-pressure water environments mostly shallow at depth of 100 to 200 meters underground. The water is very sweet and used for a number of different applications. The seal was to be placed on a thin wall stainless steel pipe run into the well and released at the bottom, allowed to swell and seal.

A number of tests were done both on the low temperature and low salinity samples and their swell was monitored. Low salinity elastomer has a tendency to deform badly because of the swell diffusion gradient.

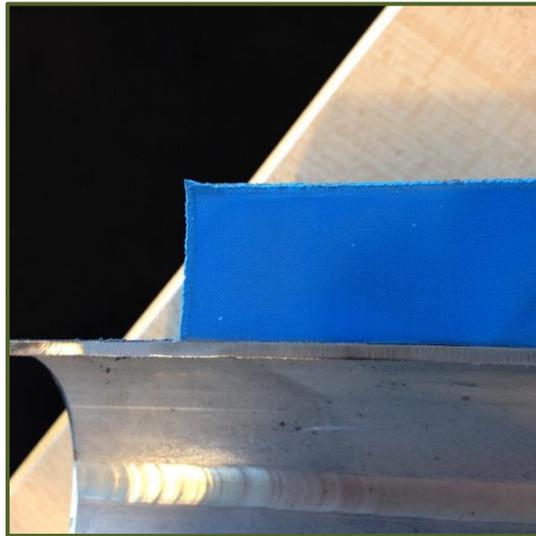


Samples were exposed to sweet low-temperature water and allowed to swell.



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The swollen sample was cut in half to look at the swell pattern



The change in the shade of the outer elastomer indicates the penetration. In the below picture, the effect of the surface area to volume can be seen in the corner of the seal and can be verified as the penetration depth.

All the tests indicated good swell, complete bonding to the stainless steel base pipe as well as not any breakaway.



A more extensive swell on this sample shows not un-towards deformation or swell problems. Normal swell tests were conducted for the suitability of compound and absolute swell values for the engineering of the swell curves. Please see the original swell curve data below as supplied. Engineering calculations were created for the strength of the pipe and seals as intended and supplied to users.

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A sample of filter pipe, supplied for measurements of ovality and production tolerances. This is extensively measured along with samples of the SS-Steel base pipe to enable these tolerances to be incorporated in the swell prediction designs.



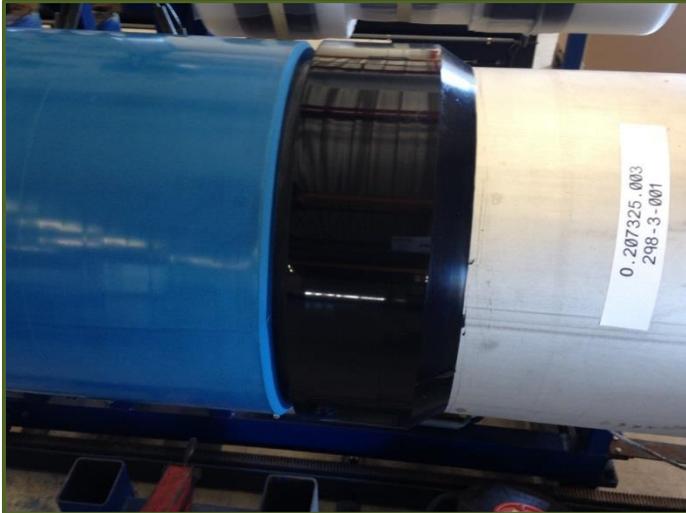
Measuring filter pipe Haitjema	8-8-2016
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Measure point	Left Side		Right Side	
	Wall Thickness	Diameter	Wall thickness	Diameter
1	12,64 mm	290,4 mm	12,85 mm	290 mm
2	12,5 mm		12,67 mm	
3	12,44 mm	291,1 mm	12,52 mm	291,35 mm
4	12,37 mm		12,6 mm	
5	12,64 mm	290,7 mm	12,34 mm	290,2 mm
6	12,54 mm		12,53 mm	
7	12,5 mm	289,6 mm	12,61 mm	289 mm
8	12,73 mm		12,75 mm	

Delta	0,36 mm	1,5 mm	0,51 mm	2,35 mm
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Swelling Seal Elastomers and their use in repair of water Wells

3.1. Manufacturing



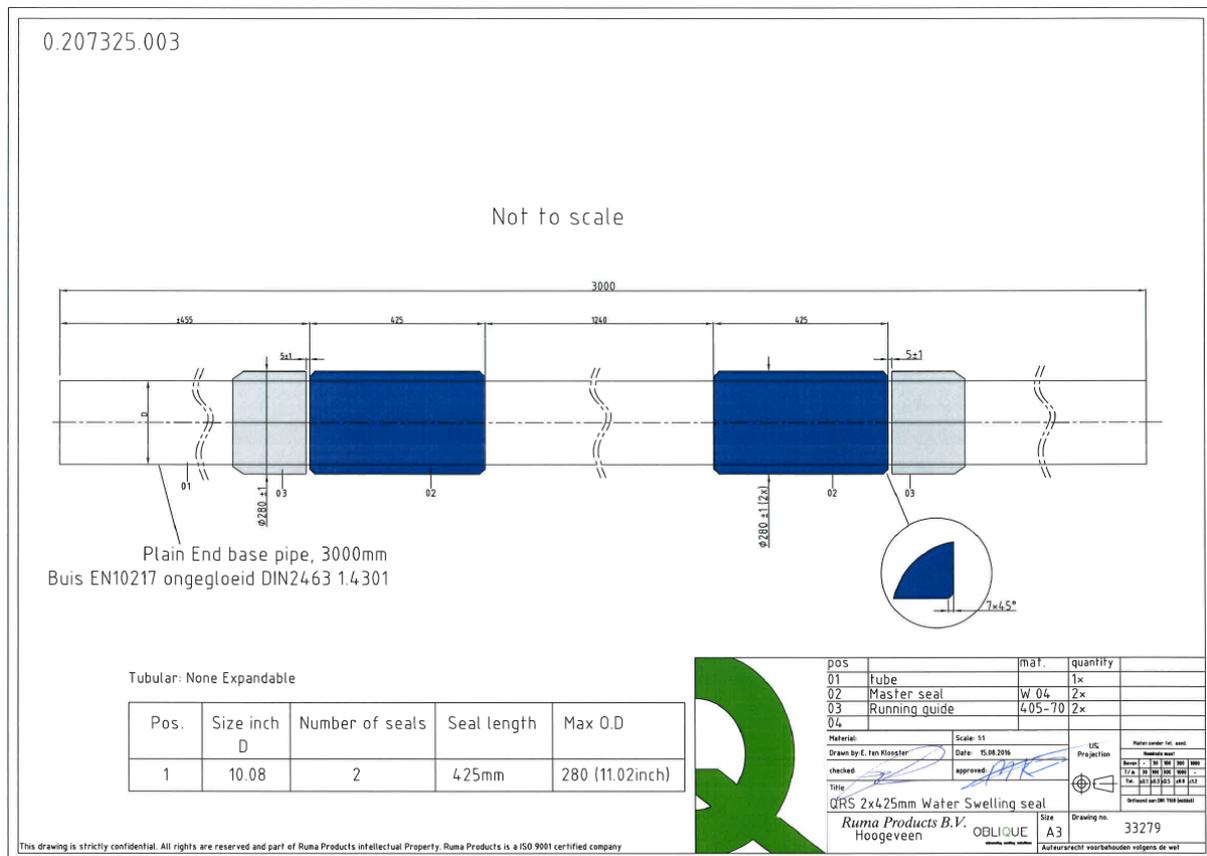
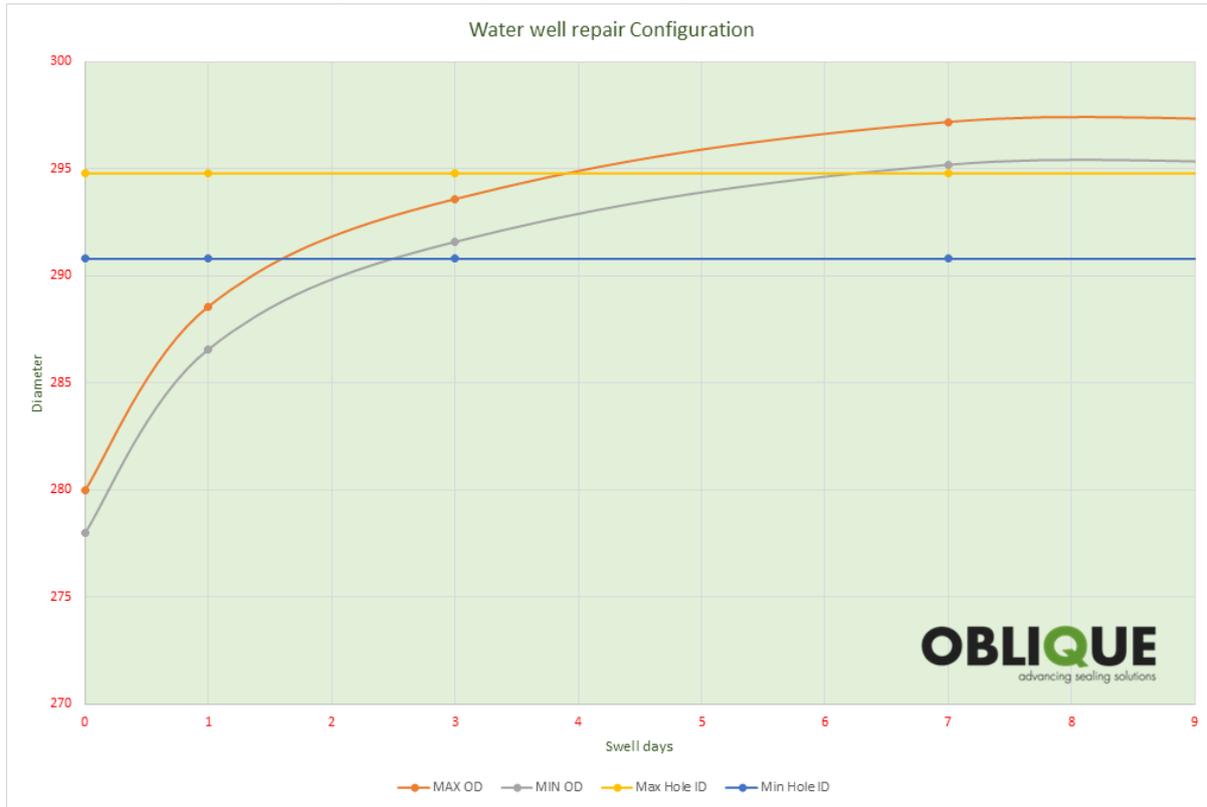
Final twin seal straddle and close-up of the seal and elastomeric black running guides.



Products wrap protected and crated, ready for shipping. Wrapping is a special UV protection also sealed against water, developed to ensure long term storage without damage to the elastomer. Tested to -50°C and up to $+50^{\circ}\text{C}$.

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3.2. Water well repair Configuration, Compound W04



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4. RUMA PRODUCTS Certification

Lloyd's Register

Certificate of Approval

This is to certify that the Management System of:
Ruma Products B.V.
Lindberghstraat 45, 7903 BM Hooerveen, Netherlands

has been approved by LRQA to the following standards:
ISO 9001:2015

P.G. Cornelissen - Area Manager North Europe
Issued by: Lloyd's Register Nederland B.V.

Current issue date: 1 December 2018
Expiry date: 30 November 2021
Certificate identity number: 10141448

Original approval(s):
ISO 9001 – 3 December 2012

Approval number(s): ISO 9001 – 0022595

The scope of this approval is applicable to:
According to specifications the design and development, engineering, testing, manufacturing and delivery of swelling and non-swelling sealing products and systems.

Lloyd's Register

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ISO 14001:2015

P.G. Cornelissen - Area Manager North Europe
Issued by: Lloyd's Register Nederland B.V.

Current issue date: 1 December 2018
Expiry date: 30 November 2021
Certificate identity number: 10141445

Original approval(s):
ISO 14001 – 31 January 2014

Approval number(s): ISO 14001 – 0022596

The scope of this approval is applicable to:
According to specifications the design and development, engineering, testing, manufacturing and delivery of swelling and non-swelling sealing products and systems.



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Current issue date: 12 July 2021
Expiry date: 29 June 2024
Certificate identity number: 10376113

Original approval(s):
ISO 29001 – 25 June 2015

Certificate of Approval

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Ruma Products B.V.

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has been approved by Lloyd's Register to the following standards:

ISO 29001:2020

Approval number(s): ISO 29001 – 0022594

The scope of this approval is applicable to:
According to specifications the design and development, engineering, testing, manufacturing and delivery of swelling and non-swelling products and systems.

Paul Graaf
Chief Operating Officer, Management Systems, MSIS
Issued by: Lloyd's Register Nederland B.V.

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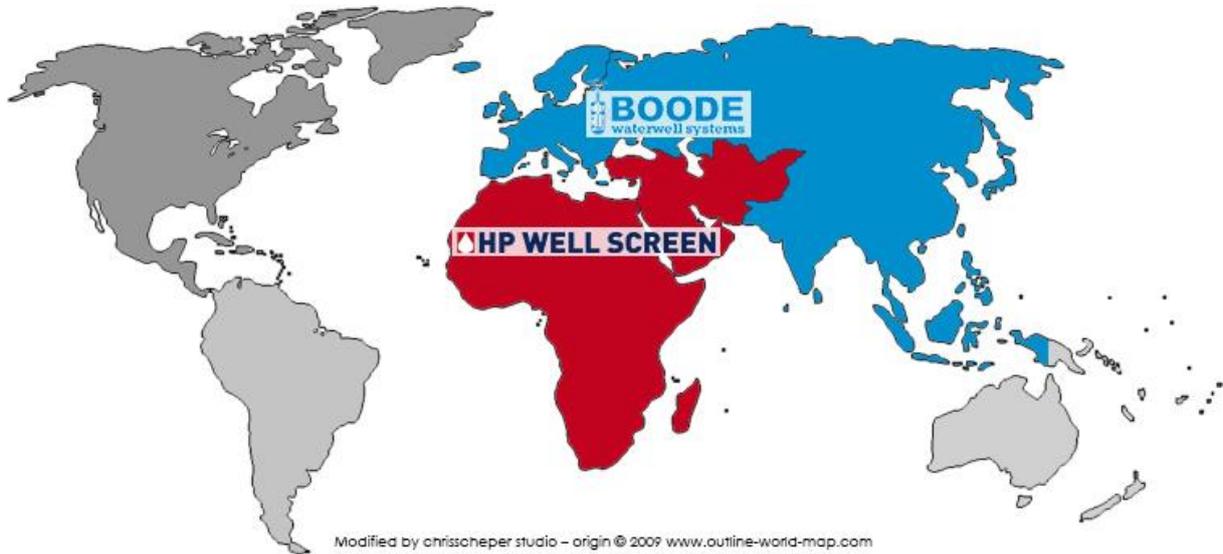
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5. References

- Oblique | www.oblique.eu
- Scheper.Co – Engineering & Consulting | www.scheper.co
- Ruma Products | www.rumaproducts.com
- Information and Trends Grondboorbedrijf Haitjema - 2016
- Nationaal Hydrologisch Instrumentarium – NHI\FASE_1+\2008\DR2\v1 – jun 2008
- AL-West BV (Agrolab) – opdracht 531602 – okt 2015 – Bron 325430 en Bron 325431
- Boode Brochure – filterbuizen – www.boode.com
- Richtlijnen voor ontwerp, realisatie, bedrijfsvoering, regeneratie van pompputten 2006
- Dino loket – www.dinoloket.nl



6. Sales & Distribution by:



Boode Waterwell Systems

Europe, United-Kingdom and Asia

Since May, 1th, 2019, Boode Waterwell Systems has become our 1st partner for the Sales & Distribution of the QRS. Please, contact Boode B.V. if you are in the high-lighted area (blue) for further details, delivery times and price overviews.

Verkoop en Distributie: Boode Waterwell Systems

info@boode.com | +31 (0) 180-632744 | www.boode.com

Sales & Distribution: Boode Waterwell Systems UK

info@boodeuk.com | +44 (0)1455-611317 | www.boode.com

HP Wellscreen and Wellslot

Middle-East and Africa

Since September, 1th, 2021, HP Wellscreen & Wellslot have become our 2nd partner for Sales & Distribution of the QRS. Please, contact HP Wellscreen if you are in the high-lighted area (red) for further details, delivery times and price overviews.

Verkoop en Distributie: HP Wellscreen and WellSlot

sales@hpwellscreen.com | +31 (0) 546-577 908 / sales@wellslot.com | +971 2 634 4441

www.hpwellscreen.com | www.wellslot.com

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