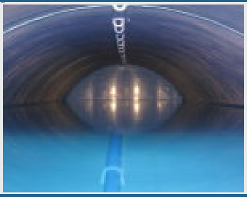
krah community - innovative pipe solutions

The magazin for large Plastic Pipe Technology
(up to DN4000mm) **05**/2012

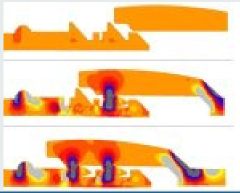
IMPROFIL

Comtruder®:
Large Plastic Pipe Production Line with CaCo3



Drinking water storage systems made out of PE 100 helically wound pipe

English | Spanish



Elastomeric Joints for Polypipe

See also:
ImProfil of: Peeter Kirtsi / Krah Pipes OÜ
Relining with large diameter Polyethylene Pipes
Preview: Members' Magazine #6

Informations:
Current Market Prices for Commodities in Middle and Eastern Europe

Welcome to the 5th issue of ImProfil

Dear readers,

I am very delighted to invite you to read the first issue of our newsletter in 2012.

Until today the number of recipients has been increased to approximately 1500 and we can record continuously new registrations of pipe consultants, pipe producers and other organizations related to our business.

Also in this issue we have a lot of interesting technical reports on larger diameter pipes, especially also regarding $CaCO^3$ as filling material for sewage pipes out of PE and PP. Also the newly developped Comtruder®Technology offers the pipe producers the possibility to avoid expensive compounds by adding filling materials up to 25% inline directly during production according to existing norms. The filling material increases the stiffness of the pipes considerably and thus helps to safe costs.

Furthermore you can find some projects reports of Krah Pipes in the application of drinking water and relining, as well as regarding the mathematic calculation of the moment of inertia used for the pipe dimensioning.

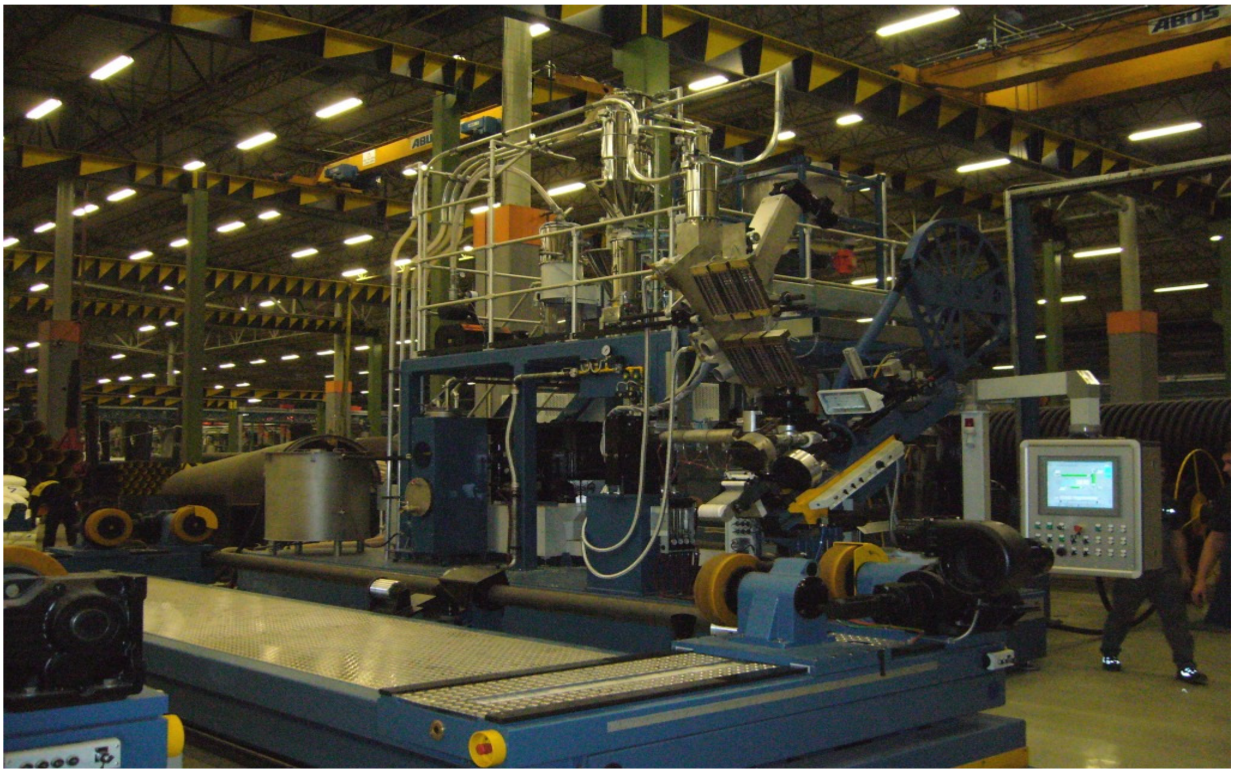
Last but not least you can learn something about our long-term partner Peeter Kirtsi from Estonia in our interview serie “10 questions for…” I hope you will enjoy this issue of improfil and we are looking forward to receiving your feedback and improvement suggestions.

Best regards from Germany,

Alexander Krah / CEO of Krah AG

Comtruder® - Large Plastic Pipe Production Line with CaCo3

Our last development in the field of large plastic pipes is the production of pipes filled with 25% Calcium Carbonate. The new pipe system fulfills all requirements for pipes according to the European standard EN13476. We produced several pipes on one of our latest extrusion lines with an integrated Comtruder®. During the extrusion process, PE100 and calcium carbonate powder are mixed and extruded in one step. The pipes were produced with 75% Sabic HDPE P6006 (PE100) and 25% calcium carbonate powder CaCO3 (in further tests we produced pipes with 30% calcium carbonate). The same pipes were also produced with virgin HDPE SABIC P6006 (PE100). Pipes were produced as solid wall and also as structured wall pipes.



The picture shows our latest Comtruder® production line, able to mix- and extrude several materials.

<u>The following pipes were manufactured:</u>

a. Pipe DN1000 x 6000 structured wall pipe: PR54-4.5 ends: smooth-smooth
b. Pipe DN1000 x 2000 VW12/24 smooth-smooth ends
c. Pipe DN600 x 6000 VW20 smooth-smooth
d. Pipe DN600 x 6000 VW20 smooth-smooth

All pipes were produced with our standard machine “KDR750+”, standard dies were used and the output was according to the programmed settings. A large effect by using calcium carbonate was the significant reduction of the cooling time by approx. 10%. After -the production, the pipes were stored for 24 hours before starting the pipe tests.

Drinking water storage systems made out of PE 100 helically wound pipe

Potable water is the most important food on earth and is not replaceable. The natural element of water is the basis of earthly existence. In Germany, water is the purest and most monitored food. It is constantly tested for quality and ingredients. The daily consumption of water in Germany is 120 liter per citizen – this corresponds to an annual consumption of 4 billion cubic meters. Such huge amounts of water are not required simultaneously throughout the day and are therefore not taken from the water system at the same time. Therefore water storage systems are needed to cover the consumption peaks and the operational standstill periods during the water transportation.

Standards and guidelines

The quality of potable water is legally regulated in the Drinking Water Ordinance. Fundamental basis of the Drinking Water Ordinance is its direct connection to the generally accepted rules of technology like for instance the DVGW regulations and the DIN standards. The harmonized European standard DIN EN 1508 “water supply – requirements on systems and components of the water retention” comprises the normative foundations for storing drinking water. In addition, the DVGW worksheet W 300 “water retention – design, construction, operation and maintenance of water supply tanks within the drinking water supply” reflects detailed regulations of the actual state of knowledge in Germany. Both regulations were originally created for storage systems made of concrete but are also applicable to storage systems out of other materials. It is not intended to change existing tanks but to correspond to the standard, it is intended to “support“ the production of new water storage tanks.

The material Polyethylene

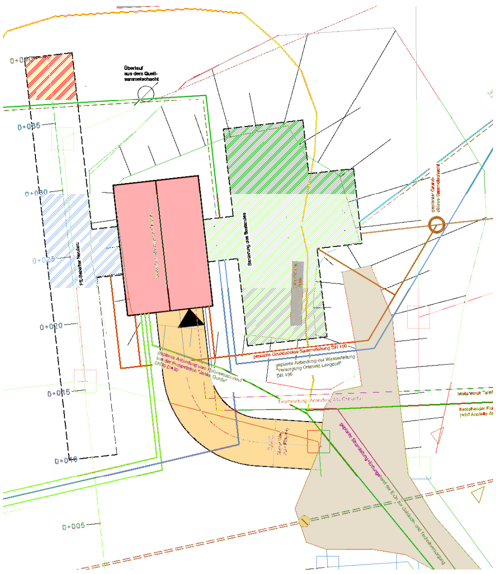
Polyethylene has been used successfully in the gas-and drinking water supply in form of pipes, molded parts and shafts for many decades. But there is also an increasing demand for PE for the renovation of potable water storage tanks. Therefore it was only a matter of time until the demand for PE for the new construction of drinking water storage systems appeared. The advantages of

Polyethylene in comparison to concrete are the resistance to external environmental influences and the maximum chemical resistance, the low specific weight and thus the simple handling of the work site, the opportunity for prefabrication of large parts in the workshop to ensure a rapid completion on site and the simple cleaning of the very smooth surfaces. Further advantages, with regard to other materials which are used for the construction of potable water storage systems, are for example the comparatively simple processing, the enhancement possibilities, the possibility of modification and the possibility of recycling. The PE 100 raw materials which are used for the construction of potable water storage systems are accredited for the transport and the storage of potable water by the DVGW and KRV and are equivalent to the requirements of the DVGW worksheet W 270 “multiplication of microorganisms on materials intended for use in drinking water systems – examination and evaluation”. The profiled pipes from FRANK & Krah GmbH which have been used throughout the construction, have a general technical approval of the DIBt with which the basic requirements for the construction of potable water storage systems out of PE 100 helically wound pipes are fulfilled.

Definition potable water storage system

The worksheet DVGW W 300 defines potable water storage systems as a closed unit for potable water, which includes water chambers, a control house and operation equipment, provides opportunities to access, includes operating reserves, guarantee pressure stability and is therefore compensating fluctuation of consumption. As the regulations do not make any restrictions in the design of tanks, it opens the door for numerous opportunities. The imagination knows almost no bounds in this respect. Nearly everything is possible – however, the highest aim is always to build a technically sophisticated solution conforming to standards and which is economically attractive. By producing potable water storage systems which are manufactured out of PE 100, it must be noticed that the current maximum inside diameter is 3500mm. Therefore the storage capacity has to be realized through appropriate pipe lengths thus it has to be ensured that sufficient space is available. The transport of the pipes to the construction site also must be considered. The graphical material is showing a potable water storage system with an inside diameter of 3500mm, which was planned by the engineering consultants Kiendl & Moosbauer from Deggendorf with technical assistance from Frank GmbH. As the access route to the existing and still in use storage system was very narrow, the new PE water chamber was delivered in individual segments. The assembling and installation to the existing building was realized in only one week. After the commissioning of the new PE 100 pipe container, the second water chamber will be redeveloped with HydroClick plates out of PE 100.

Construction of potable water storage systems



Generally, the potable water storage system consists of two separate water chambers to ensure aproper execution of inspections and cleaning intervals. The map detail is showing the left (green marked) water chamber of the potable water storage system, which was produced out of PE 100 pipes. In the middle (pink marked) there is the control building where the de-acidification machine is located. To the right of it (grey marked) there is the second masoned water chamber, which will be redeveloped with Hydroclick plates out of PE 100. The pipelines of the water chambers were guided through the control house so that the water chamber walls can be inspected at any time. The control house should be carried out in such a way that an easy handling and cleaning of the storage system can be ensured.

The access to the water chambers must be secure and must allow an easy operation. The openings required must comply with the effective UVV regulations and shall be large enough to transport materials and equipment for repair and maintenance purposes through it. Special facilities for taking samples in the control house for any increasing and extraction line are most useful in order to ensure that operation is possible without the need of entering the water chambers. The aerator and venting facilities for the water chambers and the control house must be separated technically. The water chambers must be equipped with a bypass to connect the supply system with the discharge water system. The overflow must be designed in such a way as to enable the function of draining excessive water. Therefore the overflow has to be appropriately dimensioned and cannot be equipped with an isolating device. The surface of the stored water must be visible all the time in order to control the water chambers in the best way. To do this, it is reasonable to install special inspection glasses in between of the control house and the water chambers, different lightning options in the water chambers can also be installed. The VDE-regulations for “damp and wet environments” must be considered here.Appropriate lightning protection equipment should also be considered.

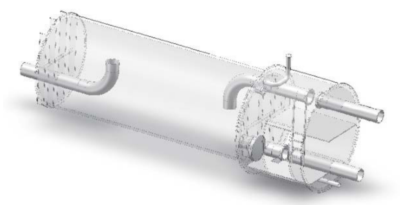
The water chamber is a closed part of the potable water storage system with separate supply-, extraction,- overflow,- and draining devices which can be operated independent of other water chambers. The access to the water chamber should not be possible in filled condition so that a pollution of the drinking water can be excluded. Normally, it is possible to have access to the water chamber through the control house. The main controls and instruments, pumps and monitoring devices are also housed in the control house.

The size of the potable water storage system is determined by the summation curves of the supply and draining device and by the operating reserve. Water storage systems with a maximum daily demand of less than 1000 cubic meter, have a cubic capacity of 35% of the maximum daily demand according to the DVGW worksheet W 300.

As the currently largest diameter for helically wounded pipes is DN 3500 mm, the maximum active storage is approximately 9,2 cubic meter per meter. With two separated water chambers with a length of 35 m length each, there will be an active storage of 650 cubic meters of potable water. For stabilization of the water pressure a water depth of 3,5 meter was proven to be useful. Therefore lying PE 100 pipes with a diameter of DN 3500 mm are representing a very attractive alternative in comparison to other materials like concrete or GFK (glass fiber reinforced plastic).

Hygiene Regulations

The wetted surfaces which are needed for the construction of water chambers must be made of materials which shall meet the test requirements. Especially for additives, which are required in the use of concrete and cement mortar,it must be examined if they meet the requirements for potable water storage systems. When plastics are used it is important to ensure that the plastics meet KTWrecommendations whose suitability must be demonstrated from a microbial point of view according to D VGW W 270.



The surfaces of the used materials need to be as smooth as possible and of the lowest possible porosity to ease subsequent cleanings and to avoid bacterial growth. With the use of PE 100 pipes and plates this demand will be accomplished. Mineral construction materials like concrete or cement mortar have to be high-quality coated subsequently or have to be lined. Similarly, corrodible metal parts must be protected accordingly to avoid contamination of the drinking water. In the planning and construction of water chambers special care is needed to ensure that there are no areas in which the water stagnates. A constant circulation of the water avoids the risk of scaling on the walls of the water chamber. Fluid flow caused by the inclined water is often already sufficient to produce adequate circulation and mixing. Here, round containers are providing aerodynamic benefits in comparison to angular containers as the covered surface is more even circulated at the same storage volume.

Aerator- and venting facilities

Ventilation installations in the water chambers are needed to allow air movements which are caused by changes in water level. The aerator- and venting facilities are being implemented for hygiene and taste-related reasons. Their dimensioning follows the outgoing through flow or rather the maximum limit for the air speeds in the ventilation facilities. Filtering and water straining equipment is highly recommended to prevent drinking water contamination. For this reason, the openings of the water chambers should not be above the free water surface. Two projects with receiver tanks which were carried out by the public utility company in Bühl, were equipped with efficient air-and air escape valves as the storage capacity of in total 100 m³ per day was handled up to 25 m³. The complete design and planning of the entire system was carried out by the engineering company Eppler in Bühl.

Static design

In order to ensure a static load carrying capacity of the storage systems, to facilitate the integration of storage systems in the landscape and to keep the maintenance costs as low as possible, the high above ground level should not exceed one meter. Permanent and variable impacts need to be taken into account with the static design of water tanks. Permanent impacts are for instance soil loads, pressure by groundwater, dead load of the building as well as the weight of the operational installations. The major variable impacts are for example the weight and the pressure of the stored water, snow loads, wind loads and impacts resulting from maintenance work. Drainages must be installed in the bottom and on the side of the tank in order to restrict impacts by existing ground water to a minimum. Thus, the water tank can be built on grounds with a sufficient load capacity. However, it must also be kept in mind that the ground is not contaminated in order to avoid pollution of drinking water through diffusion of toxic substances through the tank walls. The same applies to the filling material.

Commissioning

Prior to commissioning of potable water tanks, a tightness test as well as a cleaning and disinfection of the storage system must be carried out. The tightness test is considered passed if a visible water outlet is not determined and if there is no measurable decrease in water level within a testing period of 48 hours. During the cleaning of the storage tank the use of chemical cleaning products have to be limited to a minimum. The applied materials for the water tank must be free from any damages through the use of chemical cleaning products. The products also must be investigated toxicologically and for drinking applications before using. As Polyethylene features a good resistance against chemicals, there is no reason to fear restrictions in use in case of damage of the inner surface. The use of disinfecting agents should be organized in accordance with the EU directives as well as with the national and local regulations. Recommendations to this are stated in the standard DIN EN 805 “Requirements to water supply systems and their prefabricated parts outside of buildings”. The standard also describes the permitted disinfection methods of pipelines for water supply and how to disinfect potable water storage systems. After the disinfection the microbiological harmlessness must be proved. If the microbiological harmlessness has been proven, the disinfected potable water pipes or storage tanks must be put into operation as quick as possible in order to avoid further contamination.

Conclusion

Polyethylene represents a very good technical and economical alternative in comparison to the so far used materials in the field of new development of small and medium sized potable water storage systems. There are many advantages by using PE in such applications, like for example the long-life cycle, the very good chemical resistance, the low specific weight and the possibility of variable prefabrication in the workshop. All these advantages can lead to considerable time and cost savings. After successful usage over decades of the raw material PE (approved by DVGW) for potable water piping systems, the material is also finding its way into new fields of application like for instance the new development of potable water storage systems. New areas of application for the material PE are also exploited through new innovations and developments by the industry.

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Elastomeric Joints for Polypipe

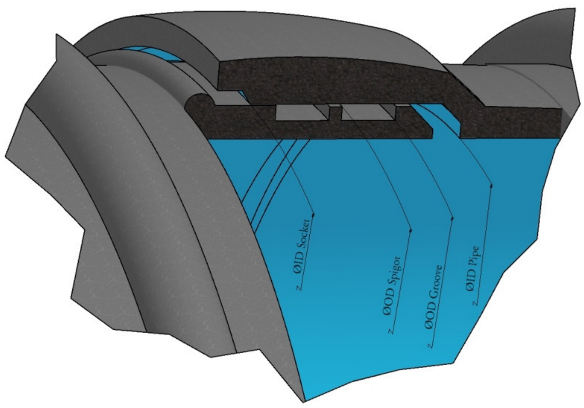
Trelleborg Forsheda Pipe Seals have proudly supplied elastomeric seals for pipe joints to Polypipe in the UK and Irish markets for more than 10 years. From EN 1401 pipes through to Ridgidrain and structured wall pipes up to DN 1050mm.

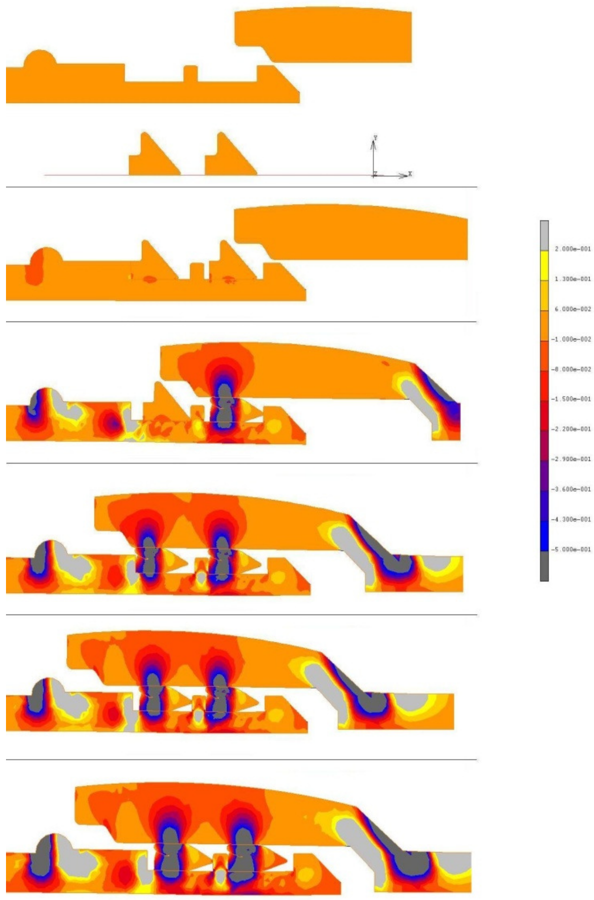
We were therefore very pleased when Polypipe became the Krah licensee for the UK and Ireland and asked us to help to develop a 'push fit' rubber jointing system for their DN750, 900 1050 & 1200mm Krah pipes. We had previously been involved with other Krah Licensees in Estonia, Italy, Mexico and the US so the Krah pipe technology was not new to us but ensuring a robust joint to meet the demands of EN 1277 is never an easy task.

In the demanding installation environments of today, the main criteria for designing joints are:

- Leak tightness from both infiltration and exfiltration
- Ease and reliability of jointing on site
- Long term durability

In approaching this type of design, and before practical jointing and physical testing can begin, a clear understanding of pipe joint geometry, dimension and achievable tolerance has to be reached. The engineers and technicians at Polypipe have an excellent understanding of the information needed and this allows us to model the joint design options using non linear finite element analysis (FEA) taking into account the maximum and minimum joint conditions. A typical simulation is shown below.





In this modelling we can take into account the stresses generated in the pipe spigot and socket and allow for any stretching or compressing of the pipe material as it reacts to the forces exerted by the seals.

Jointing force and seal behaviour can also be modelled and once the joint is optimised using FEA we then move to physical jointing and finally the joint performance tests.

The European Standard EN 13476 specifies joint performance requirements when tested in accordance with EN 1277 : Plastic Piping Systems – Thermoplastic piping systems for buried non-pressure applications – Test methods for leaktightness of elastomeric sealing ring type joints.

There are 3 basic test pressures, and 3 conditions for determining leaktightness:

Pressure KPa	Pipe Deformation % Socket	Spigot	Deflection Degrees	Test Time Minutes
Condition A				
-30	0	0	0	15
5	0	0	0	15
50	0	0	0	15
Condition B				
-30	5	10	0	15
5	5	10	0	15
50	5	10	0	15
Condition C				
-30	0	0	1	15
5	0	0	1	15
50	0	0	1	15

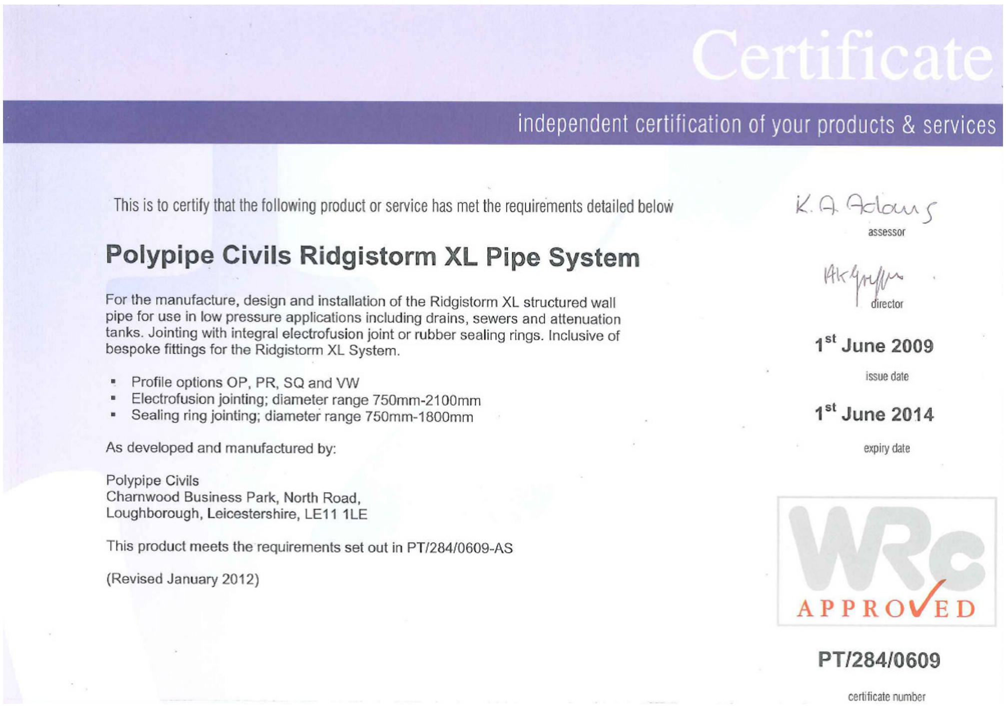
At each stage of the test the assembly is inspected for evidence of leakage.

Dn1200mm pipe joint during EN1277 condition B testing at our test laboratory.

After the successful completion of the Dn750 to 1200mm range of pipes we were asked to extend the joints to include Dn1500 and 1800mm. These larger sizes are too big for our test rig and so the Belgian Research Centre for Pipes and Fittings – Becetel performed the final joint tests for us.

Dn1800mm Pipes with welded end plates

In the final stages of the project, the UK certification organisation, WRc witnessed the joint tests before issuing the approval certification to include "Rubber Sealing Ring Joints for Ridgistorm XL Pipes Dn700 to 800mm



Certificate

independent certification of your products & services

This is to certify that the following product or service has met the requirements detailed below

Polypipe Civils Ridgistorm XL Pipe System

For the manufacture, design and installation of the Ridgistorm XL structured wall pipe for use in low pressure applications including drains, sewers and attenuation tanks. Jointing with integral electrofusion joint or rubber sealing rings. Inclusive of bespoke fittings for the Ridgistorm XL System.

- Profile options OP, PR, SQ and VW
- Electrofusion jointing; diameter range 750mm-2100mm
- Sealing ring jointing; diameter range 750mm-1800mm

As developed and manufactured by:

Polypipe Civils
Charnwood Business Park, North Road,
Loughborough, Leicestershire, LE11 1LE

This product meets the requirements set out in PT/284/0609-AS

(Revised January 2012)

K. A. Adams
assessor

director

1st June 2009
issue date

1st June 2014
expiry date

WRc APPROVED

PT/284/0609
certificate number

West – Product Manager: julian.west@trelleborg.com Trelleborg Pipe Seals, develop, manufacture and market elastomer based sealing systems for pipeline systems for water, sewerage and drainage applications.

www.trelleborg.com/pipe-seals

ImProfil of: Peeter Kirtsi

10 Questions for Peeter Kirtsi / Krah Pipes OÜ

1. **Since when do you work for Krah Pipes OÜ?**

I met Karl-Heinz Krah in Moscow in December 2005 and discussed the possibilities of starting the production with Krah line in Estonia. Since then we prepared all the documents needed, hardware required and in 2009 we had the line in our brand new production hall in Estonia. So I have been with Krah Pipes OÜ right from the birth of the idea.

2. **What is your position in the company?**

I am one of the owners and also CEO of the company.

3. **What did you do before starting your job at Krah Pipes OÜ?**

I worked for Silmet Ltd (today Molycorp Silmet Ltd). Company specializing in the production of rare metals and rare earth metals. I held the position of CFO at the time when I decided to leave the company and continue with the Krah Pipes OÜ.

4. What are the characteristics of the company compared to the competition?

I think we are "craziest" of them all, meaning that we look for complicated projects and solve problems found there. Or course, we never say no to some simple pipeline, but our goal still is to offer full solutions to problems out there and by doing that change the old classics like concrete, metal etc to our PE solutions. So we are flexible, able to develop complicated engineering solutions, optimize the usage of materials and by doing that achieve more attractive solutions to our customers.

5. When was the company founded and how well the business is performing today?

Krah AG delivered the KR line in December 2009. So 2010 was the startup & school year. In 2011 we gave all the exams and the ongoing 2012 will be the year we can look at as the first in the adult life. In few words – we are doing good and we are working to do even better!

6. Which Krah machines does Krah OÜ own until now?

We have one KR750 line installed

7. How do you call your "Krah pipes"? (brand name)

We are simple. We sell the pipes under "KRAH Pipes" brand including also KRAH Manholes, Pumping stations, Tanks etc.

8. What is in your opinion, the most valuable competitive advantage of the Krah Production Pipe Technology?

The main advantage is the flexibility of the line. One can find a possibility to do almost anything with/on this line. It is a great tool not only for competing for existing markets but also generating new markets of one's one.

9. **Where do you see yourself/the company in 5 years?**

Still here in Estonia :) but seriously, we want to be the best plastic engineers in the region helping out our partners with the know-how and equipment we have.

10. **Please tell us more about your current most interesting projects.**

We just finished a nice relining project in Estonia where 150m segments of e-fusion welded Di800 pipe were pushed into existing concrete pipeline. In March we got our first oil separator NS6 class certified. Also in March our pipes, fittings, manholes, tanks and pumping stations passed tests for seismologic activity and as a result receiving recommendations for usage up to 9th class (MSK-64 scale) earth-quakes. Most fierce tests were done in the range of 10th class. Also these tests did not damage our piping systems.

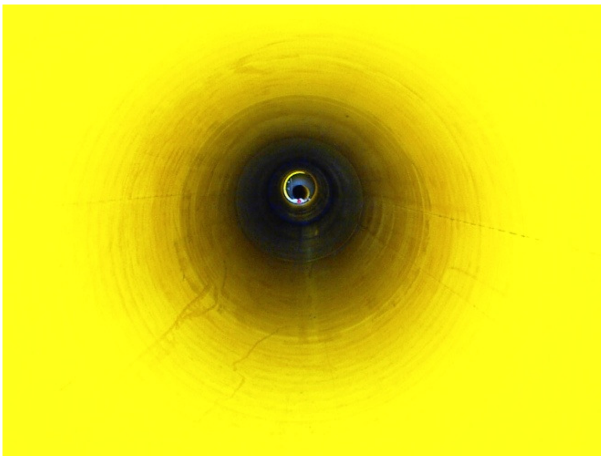
Peeter Personal

Family:	Single at the moment. Have the best sister called Maarja.
In my spare time:	I do a lot of sports. I play ice hockey and do boxing. During off-season just jogging. And a night out is always a good idea :)
I am just reading...	one of the Chinese classics “The Complete I Ching” by Alfred Huang
I can laugh about...	I think about almost anything depending on the situation and day.
My favorite Food:	I just adore good food, so there are many favorites. In general I love hot foods & meat a bit better than anything else.
My favorite holiday destination:	anything but regular “tourist spots”

Relining with large diameter Polyethylene Pipes

Damaged and leaky pipes out of concrete, GRP, steel, ductile iron can be relined and renovated with Profiled Polyethylene Pipes in almost every diameter. Here, the old pipe serves as an empty conduit for the new pipe out of PE and therefore a completely new, self-contained pipe system can be built. However, the use of profiled pipes especially in big diameters creates new stable pipe systems with a high static load capacity. For the static calculation of the new pipeline two things must be taken into consideration, the installation process and the operating condition of the pipeline. The new system will benefit from the extremely long service life of polyethylene pipes (> 100 years).

old and damaged sewer



new relined sewer

The relining process with polyethylene pipes has proven its reliability in almost all fields of application for many years:

Renovation of leaky sewer pipelines

- Renovation of corroded drinking water pipelines
- Provide a seal against leakage or infiltration
- Gas supply systems (Changeover to higher operational pressures)
- Renovation of inverted siphons
- Industrial applications (aggressive media, acids, alkalis etc.)

During the relining process with large-diameter polyethylene pipes, the pipe lengths are either inserted or drawn-in according to the application and environmental conditions. Which procedure will be selected depends essentially on the space conditions prevailing on site and of course on the existing machines and tools. The occurring load for polyethylene pipes is completely different during the pulling through process in comparison to the insertion. This must be considered when dimensioning, during the selection of materials and in the selection of the pipe connection.

Pulling through process

During the pulling through of a pipeline, the pipeline is exposed to axial tensile loading. This leads to an expansion of the pipe. This effect is reinforced by the bending loads which can arise in the angles of the old pipeline. The insertion forces are increasingly dependent on the length of the pipe to be installed, the weight of the pipeline, the ring gap, the interior surface of the old pipe or rather the friction between the old and the new pipe. The old pipe must be cleaned and if possible removed from encrustations. It is also advisable to apply enough lubricant in order to reduce the friction. Water is also often used for this reason.

Separate sliders which are fixed on the outside of the new PE pipe or in the old pipe. The choice of the correct product for the reduction of the frictional resistance always depends on the corrosion status and the cleaning condition. The choice of the pipe connection can have an impact on the arising friction forces; this is particularly the case if the connection sockets can reduce the ring gap.

The external pipe surface is mechanically stressed during the pulling through process. Notches and grooves can occur and must be considered when making the static analysis. Notches and grooves can be a weak spot regarding the durability of a new pipe system. The PE raw materials were continuously optimized in the last years especially for this kind of load. Advanced polyethylene pipe materials of strength grade MRS 8 or MRS 10 have therefore a greater groove insensitiveness and resistance to slow crack growth. The pipe producers are indicating special values of many kinds in their data sheets according to several testing methods (Notch-Test, 2-NCT, FNCT etc.). These should give information or at least a reference point regarding the resistance against slow crack growth. Depending on the respective country and the application there are some national defined minimum values. The used materials must meet the requirements. The German Institute for Building Technology (DIBt) sets the following minimum values for test stands for wound pipes out of PE100 for industrial application with regard to FNCT (Full Notch Creep Test) according to ISO 13770 e.g. : 300 h bei 4 MPa, 80℃, Akropal N 100.

The maximum permissible load during the pulling through process depends on the selected pipe wall cross-section and on the selected welding method. The force application of the pull rope or of the pull rod into the pipe must occur very evenly in order to reduce additional loads. It is recommendable to use a tension-head or tension anchors which need to be distributed at the periphery. A measuring box must be integrated within the pulling system in order to monitor the force application. The measuring box is able to advise the personnel when the tensile load exceeds the permitted degree due to unforeseen obstacles or a to high friction resistance.

The pulling through process must be closely monitored and comprehensively documented. Especially angular deflections within the pipe string can lead to a unexpectedly high tensile resistance. For the calculation of the permissible tensile force, the following factors have to be taken into account – the expected loading duration and the ambient- pipe temperatures. The tensile loading can last a few minutes or several hours depending on the length of the pulled pipe segments. In practice, the load period is often set with 24 hours. The corresponding tensile dimensioning can be taken from the creep strength curves, which are listed in the relevant standards or which are provided by the respective pipe producers.

$$F_{ax} = \frac{A_{ax} \cdot \sigma \cdot C_W}{S_f}$$

F_{ax} = axial forces [N]

A_{ax} = axial area [mm^2]]

σ = design strength (from creep rupture curves) [N/mm^2] for the required time and temperature

C_W = Welding factor [-]

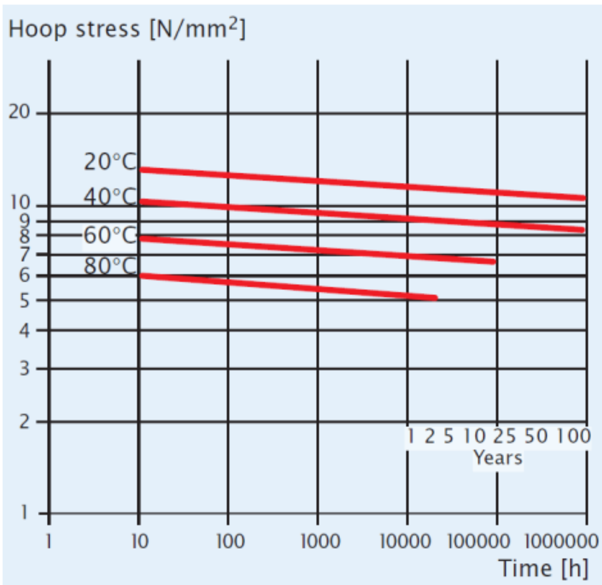
S_f = safety factor [-]

The respectively thinnest and weakest wall thickness is the decisive factor for the dimensioning notably in the field of profiled pipes. The same also applies in individual cases within the spigot or the preformed socket. The welding factor can be found in the applicable standards. The Manufacturer's instructions are binding for the electro fusion connection. The pipe producer can get an overview of the efficiency of the weld connection by taking a tensile specimen of an exemplary weld according to the ISO 527 standard.

Table 3. **Short-term (f_z-) and long-term-(f_s-) weld factors.**

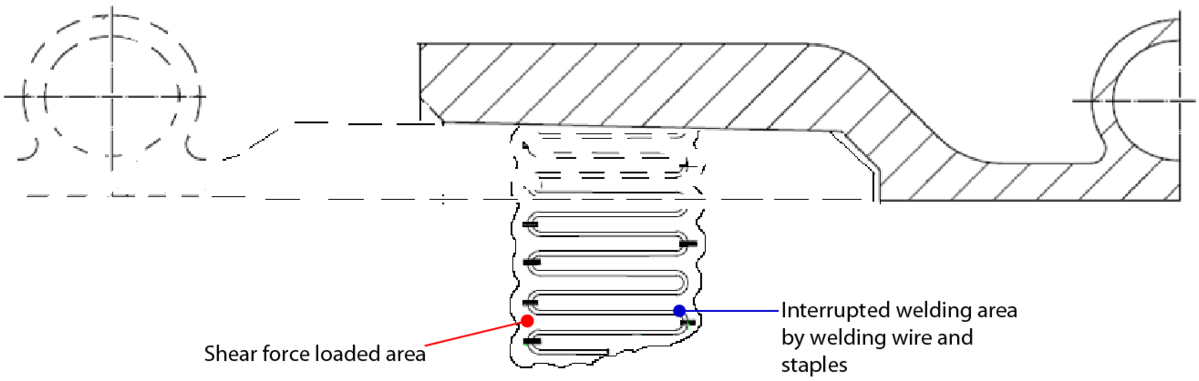
Materials / Processes		PE-HD	PP	PVC-U PVC-HI	PVC-C	PVDF
Heated tool butt welding HS	f_z f_s	0,9 0,8	0,9 0,8	0,9 0,6	0,8 0,6	0,9 0,6
Hot gas extrusion welding WE	f_z f_s	0,8 0,6	0,8 0,6	– –	– –	– –
Hot gas welding W	f_z f_s	0,8 0,4	0,8 0,4	0,8 0,4	0,7 0,4	0,8 0,4

Welding factors according to DVS 2203-1 / 2205-1:



Source: Technical Manual-Materials used in Pipe Extrusion, LyondellBasell

When using electro-fusion sockets, it should be noted that the transferable shearing stress comes to around 50 % of the hoop stress. For the calculation of the subject to shear welding area, the interruption by welding wire must be considered.



$$F_{ax} = \frac{A_w \cdot \sigma \cdot C_W}{2 \cdot S_f}$$

F_{ax} = axial forces [N]

A_w = welding area (without wire area) [mm²]

σ = design strength [N/mm²] for the required time and temperature

C_W = Welding factor [-]

S_f = safety factor [-]

Push in procedure

During insertion of the pipe line, the line is not loaded on tension, it is primary loaded on distortion, buckling and compression. The loading duration is similar to the pulling through process and depends on the length of the pipe segments.

For the calculation of the compression stress it is possible to apply to the creep strength curves. The typical values of the pressure resistance are normally higher but however, it is useful to keep the deformation exposed through higher stresses relatively small in order to prevent forming of the shape of the pipe.

The used formulas for the distortion and buckling are reflecting the ideal circular /cylindrical condition. The stronger the pipe deviates from this, the lower is the resistance against distortion and buckling (Stability Consideration).

Formula for calculation of critical length

$$L_k = \sqrt{\frac{E \cdot \Pi^2 \cdot I_{pipe}}{F_{ax} \cdot S_f}}$$

L_k = buckling length [mm]

F_{ax} = axial compression forces [N]

I_{pipe} = Moment of Inertia of pipe ! [mm^4]

E = flexural modulus [N/mm²] for the required time and temperature

S_f = safety factor [-] (should be 2 for stability calculations)

with:

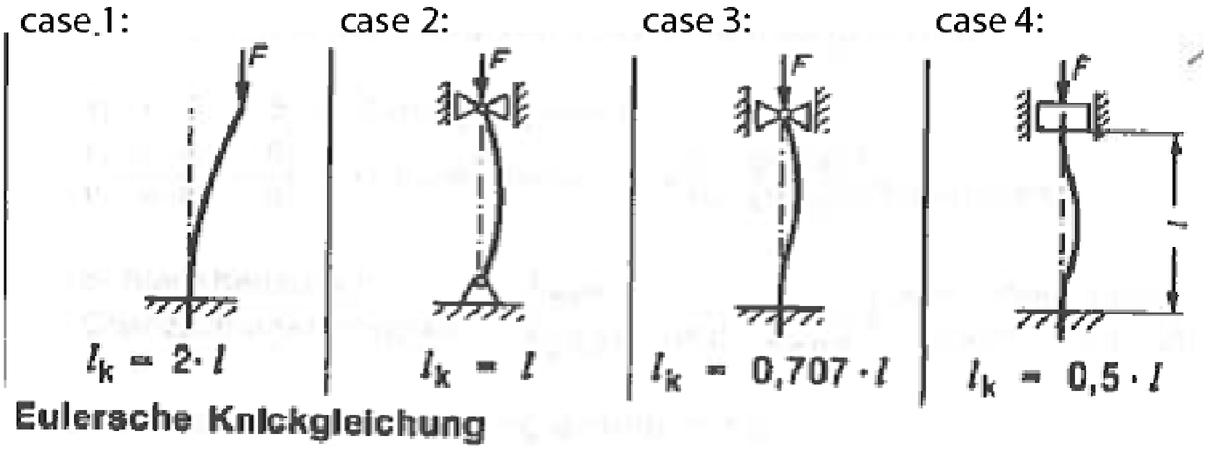
$$I_{pipe} = \Pi \cdot \frac{OD^4 - (OD - 2 \cdot e_{equ})^4}{64}$$

I_{pipe} = Moment of Inertia of pipe ! [mm^4]

OD = outside diameter pipe [mm]

e_{equ} = equivalent wall thickness pipe [mm] (at solid wall pipes = wall thickness)

Euler case 4 is equal to situation of Relining-Pipe, therefore is the critical length “L” equal “2 x L_k”



Injection grout mortar

When designing the new pipe for taking the load by soil, traffic etc. the space between the old and new pipe must be filled with injection grout mortar. This procedure is necessary to generate a defined load situation. Static calculations for relining pipes can be done according to ATV M127.

During the injection procedure the pipe is stressed by radial buckling. The buckling pressure depends on the injection pressure and hydrostatic pressure due to the density of the grout mortar and the height between the pipe and grout mortar tank.

The radial buckling resistance of a pipe can be calculated as follows:

$$p_k = \frac{20 \cdot E \cdot e_{equ}^{\ 3}}{(1-\mu^2) \cdot (ID + e_{equ})^3 \cdot S_f}$$

E = flexural modulus [N/mm²] for the required time and temperature

ID = inner diameter pipe [mm]

e_{equ} = equivalent wall thickness pipe [mm] (at solid wall pipes = wall thickness)

S_f = safety factor [-] (should be 2 for stability calculations)

Furthermore the lifting force during the injection process must be kept in mind. A distance holder at the crown between the old and the new pipe can reduce the lifting force. In any case, the lifting force must be lower than the weight force of the considered pipe segment between two distance holders. To avoid floating of the new pipe, the pipe can also be filled with water during injection of the grout mortar.

$$F_{lifting} = \frac{\Pi \cdot OD^2}{400} L_{dh} \cdot \gamma_{gm}$$

$F_{lifting}$ = lifting force [N]

OD = Outer diameter pipe [mm]

L_{dh} = distance between distance holder [mm] (at solid wall pipes = wall thickness)

γ_{gm} = Density grout mortar [kg/dm³]

In summary, there are many load cases to consider for designing a relining-pipe-system. The described technical backround show only a part of it and of course there is more. But at the end all based on physical effects and plastic engineering!

Plaspitec provide Engineering and Consultancy for plastic pipes Systems!

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Preview: Members' Magazine #6

During the winter of 2012 a renovation ca 1000m of concrete pipeline was planned. Several different solutions were considered for completing the job. The local water authority and the construction company both found the solution proposed by Krah Pipes OÜ the best. This solution proposed Di800 e-fusion connected pipe segments to be installed inside the existing pipeline.

Find out more information about this report in the n ext issue of this newsletter!