krah community - innovative pipe solutions

The magazin for large Plastic Pipe Technology
(up to DN4000mm) 06/2012

IMPROFIL

Welcome to the 6th issue of ImProfil

Dear readers,

Although everybody is talking about the worldwide crisis, the market for innovative plastic production machines and construction industry in general is still booming in many parts of the world.

Governments of countries try to improve the difficult global situation by generating economic activities mainly in the area of infrastructure projects. New and infrastructure projects that were on hold are now pushing also the market of large diameter pipes and pipe production machines.

New innovative pipe systems increase the chances for plastic pipes to be considered by project planers, contractors and civil engineers.

One of those innovations and the main subject of this issue is High Modulus Polypropylene and its comparison to conventional plastic pipes.

I hope you enjoy this edition and we are always keen to know your comments, suggestions and wishes regarding the past and future newsletters!

With kind regards

Alexander Krah
CEO of Krah AG

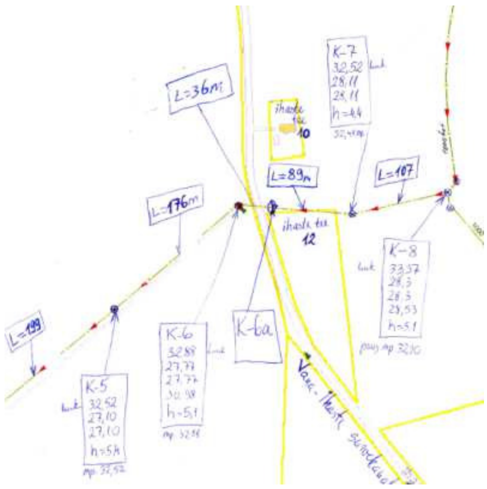
Tartu Ihaste DN1500 Pipeline Renovation Project

Introduction

Tartu, with its population of 101,246 (Population Census data from 2000) in an area of 38.8 square kilometres, is the second largest city of Estonia. Tartu, lying 185 kilometres south of Tallinn, is also the centre of Southern Estonia. The first written records of Tartu date from 1030.
With the constant development of the rainwater and sewage pipelines, city of Tartu arranged tender to renovate old 1500mm concrete rainwater pipeline.

Project description

Mission: To build a new sewage pipeline from the manhole K8 to K1, overall length of the pipeline is 961,5 meters. Concrete manholes shall be replaced with new PE manholes. PE manholes should be ID1000 and there must be room for the portable ladder, hatches of the manholes have to be with a load capacity of 40 tons. The existing pipeline is DN1500 reinforced concrete. Minimum internal diameter of the new pipeline has to be 800mm. All the pipe joints of the new pipeline have to be welded.
Space between the new and old pipeline has to be filled with concrete.



Pic. 1 – Project blueprint

Project execution

First idea to replace the old concrete pipeline with an open trench method was quite impossible due the really high installation depth – deepest point of the concrete pipe was in 8 meters. Alternative solutions were looked for and among these was Krah Pipes OÜ's solution. The solution offered was Krah ID800 pipe with electro-fusion connection and trenchless installation. Pipe would be pulled/pushed into the existing pipeline. Construction company choose Krah´s solution, their request was that the pipe should be SN8. Pipes were offered with a vprofile PR54-004.39 s1=5mm, s4=4mm, a=120mm.

For the installation this pipeline was divided into the 4 homogeneous units
1. From K8 to K6 196m
2. From K6 to K4 375m
3. From K4 to K3 193m
4. From K3 to K1 186m

Pic. 2 – Length of the longest segment is 375m

Each of the segments was pre-welded above the ground and pushed into the old pipeline as one piece of the pipeline. For that the construction company had to dig only from 4 places a trench with a length of approximately 40 meters.

Pic. 3 – Preparation for the welding of two segments

Construction works took part in January and February 2012 with the average temperature around -10 degrees. Main reason for working in the winter time was the high ground water level in this area. To avoid the ground water going into the sewage pipeline, they choose to install everything when the ground was frozen. To hold the necessary temperature of +5 degrees during the welding, tent and heat blowers were used. Pipe sockets and spigots were heated with the gas burners before the actual welding was done. Installation of a pipeline was done with the pushing method and the connections between the units were done with rubber seal connections and were welded with hand extruders afterwards.

Pic. 4 – Pushing pipe segment into the old concrete pipeline

During the installation no special machinery was used, everything was done with the same excavators they had on site to dig the trenches. One of the excavators pushed the pipeline from the back, and some of them held the pipeline up from the ground in the middle of the pipeline to prevent the crooking.

Pic. 5 – Pushing pipe segment into the old concrete pipeline

Manholes were made as a saddle manholes, Manholes K3, K5 and K7 were installed into the old concrete manholes ID1500 no digging method was used with these manholes!

Pic. 6 – Manhole ID1500

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Producer Krah Pipes OÜ
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Advantages of using High Modulus Polypropylen for gravity pipes

Pipes are getting larger and larger in diameter, but while plastic pipes are entering the huge market of concrete pipes, the main barrier is still the high price of the raw material. Some authorities still don´t accept and consider the importance of the advantages of a long life time and a sustainable pipe system, or they just don´t want to spend the money for the future of their country. So the question is how producers of plastic pipes made of High Modulus Polypropylene (PP-HM) can deal with this problem.

How can existing “conventional” pipe producers enter these markets with technically better products and very competitive prices? Today large sewage and drainage pipes are mainly produced with standard polyethylene or polypropylenes. Mostly, structured wall pipes are used for these applications according to international standards like:

DIN16961, EN13476, NBR7373,JIS, ASTM F894

Short term E-module (E) of different polyolefin materials (usually they can be used in normal single screw extruders):

E(PE80) = 800 N/mm²

E(PE100)=1000 N/mm²

E(PP-HM, BorEco BA212 E) = 1700 N/mm² (a product made by Borouge and Borealis)

To make an easy calculation, we should start with reducing a solid wall thickness by increasing the E-modulus of the material (standard material can also have a higher short time E-modulus).

<u>Technical / Theoretical approach:</u>

The formula to calculate the nominal stiffness according to ISO9969 is:

$$SN = \frac{E \cdot I_x}{(d_i + s)^3}$$

Legend:
SN= Stiffness Nominal in kN/m², according to ISO9969
E = short term E-modulus in N/mm²
Ix = moment of inertia in mm4/mm
s = wall thickness in mm
Di=internal diameter in mm

For a solid wall the moment of inertia (Ix) is

$$I_x = \frac{1 \cdot s^3}{12}$$

New Formula for Solid Wall pipes based on internal diameters:

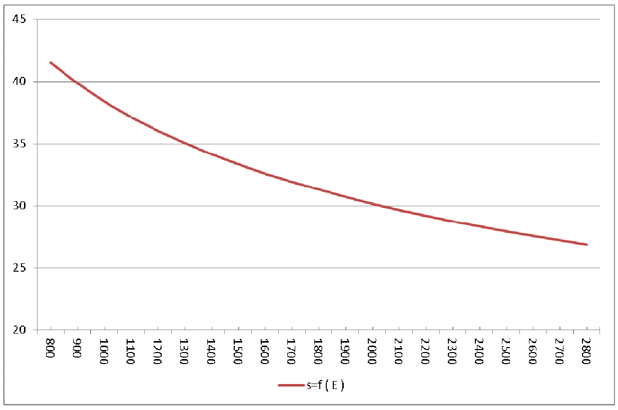
$$SN = \frac{E \cdot \frac{s^3}{12}}{(d_i + s)^3}$$

Changing of the formula to find out the wall thickness:

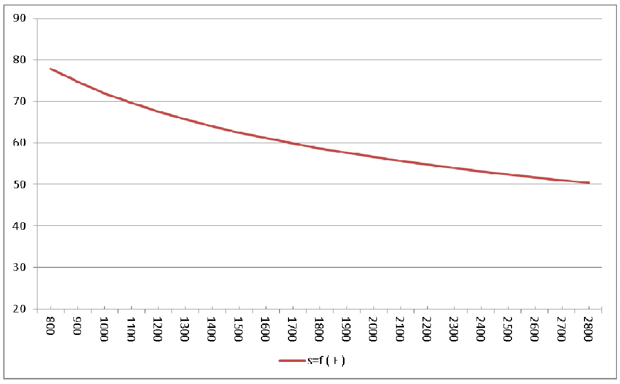
$$s = \frac{d_i}{\sqrt[3]{\frac{E}{12 \cdot SN}} - 1}$$

As follows please find three diagrams for three different pipe diameters (DN800, DN1500, DN3000), which show the reduction of the pipe wall thickness by increasing the E-modulus. All pipes are designed for SN8 and solid wall. On the x-axis you find the E-modulus of the material in N/mm² and on the y-axis you find the pipe wall thickness in mm.

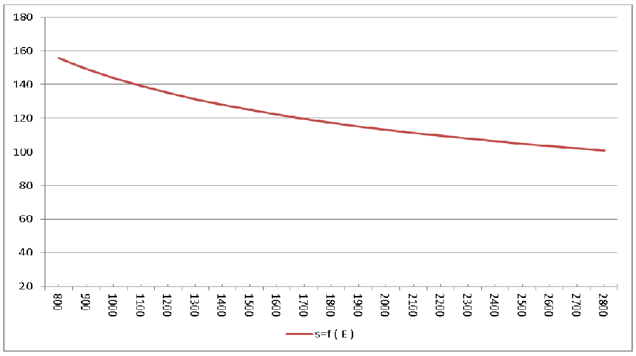
Wall-thickness-diagram DN800



Wall-thickness-diagram DN1500



Wall-thickness-diagram DN3000



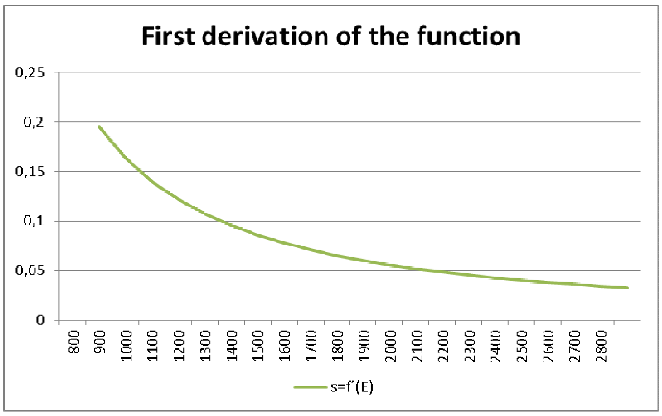
Basically the upper mentioned diagrams are showing the formula s=f(E) which means pipe wall thickness as a function of the materials E-modulus, for a constant pipe diameter and constant stiffness.

To see the mathematical effect of increasing the E-modulus we did the first derivation:

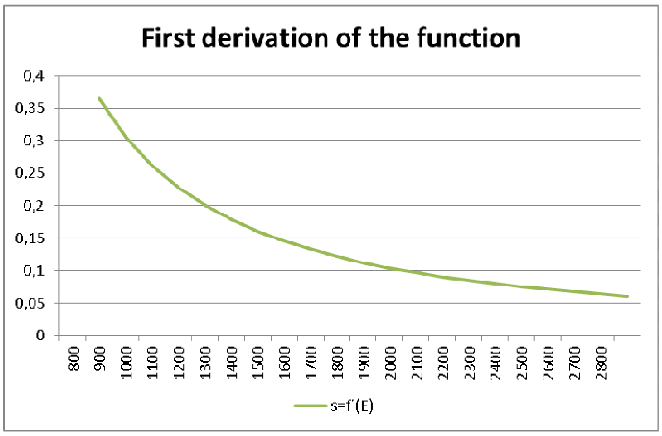
$$s = f'(E) = \frac{\sqrt[3]{12 \cdot SN} \cdot d_i}{3\,(E - 12\,SN)^{4/3}}$$

In the diagrams it will look like this:

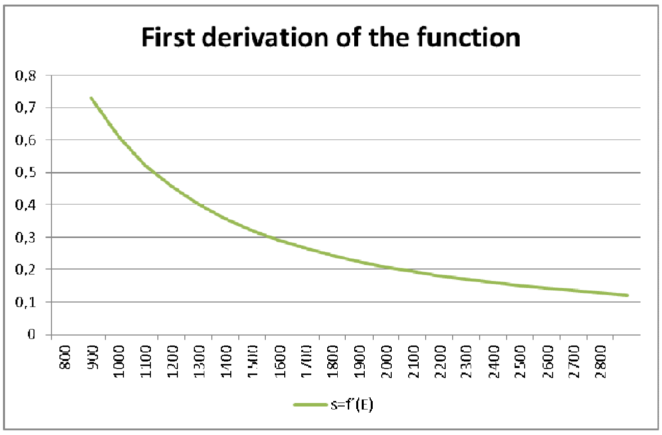
For DN800



For DN1500



For DN3000



In these diagrams you can see clearly, that the increase of the material`s E-modulus will have a reducing effect on the pipe-wall-thickness (s). The reduction of the effect will be reached earlier in smaller diameters. Further you can see clearly that the decreasing is getting flatter and flatter by increasing the E-modulus.

The question however is still if the output of the machine is the same? The density of the PP-material (0,94 kg/dm³) is a little lower than the standard PE (0,95 kg/dm³), so the output in kg/h will be lower (on a Krah-machine approx. 8%) . But due to the thinner necessary wall-thickness, the output in meter will be much more. (Usually the pipe producer of gravity pipes are selling pipes by meter not by kg).

<u>Commercial Approach</u>

Let´s assume a price of 1.470 USD/ton of PE100 and a price of 1.510 USD/ton for PP BorEco242 (Asian prices in Feb2012).

Output reduction of approx.: 8% (During test in Germany in August 2012, a pipe DN/ID900 with structured wall was produces with 760 kg/hr).

Raw material price increase of approx. 10% (in average the material costs are 70% of the total costs)
Weight reduction: 17 % per meter of pipe, for the same stiffness class.

The effect on structured wall pipes:

As an average the weight of a solid wall pipe can be reduced by approx. 40% to 60% compared to a solid wall pipe with the same stiffness, so the pipe weight for a structured-wall pipe will be reduced again and the effect of using a higher E-modulus is even higher.

Don’t forget the waterway wall thickness:

After all the positive effects of reducing the pipe weight, the minimum waterway wall thickness should be always highly considered. According to different international standards a minimum wall thickness should be given, because basically the waterway wall is the real pipe, the stiffness issue is done after complete settlement of the soil.

Result:

For large pipe diameters the usage of High Modulus Polypropylene like BorECO BA212 E can make a lot of sense, because the end product can reach attractive market prices with an absolutely good, sustainable high quality. Also a welded joint (butt-welding, E-Fusion and Extrusion welding) is possible, especially in large diameter.

However, please consider this as a theoretical approach which should be proven by practical stiffness test, according to ISO 9969.

For more details: please contact: info@krah.net

Krah Comtruder® Technology ready for High Modulus Polypropylene BorEco BA212 E

In August 2012 representatives of Borouge and Borealis have visited Krah AG to attend the tests of the Krah Comtruder®-Technology using their high stiffness Polypropylene. The tests were made on a machine sold to the Ukraine and the test runs were made using BorEco BA212E. The customer was very pleased about the results of the extrusion trials.

The test results are very satisfying and the output of 760 kg/h for a profiled pipe made of BorEco BA212E (DN 900, SN 12) demonstrate the excellent performance of the Krah Technology with a High Modulus Polypropylene material.

Both companies have agreed to develop together a completely new and innovative pipe system utilizing BorEco212E, mainly for pipe sizes in the range 800 mm to 4000 mm, including jointing, fittings and manholes. The complete pipe system will be produced by using Krah-Winding Technology. One of the main advantages is that only one production technology is capable of producing the complete range of pipes and pipe accessories in all diameters.

The possibility of the Krah Comtruder® Technology to add CaCO3 or Glass Fibers to High Modulus Polypropylene boost the competitiveness for large diameter plastic pipes against other materials. In the future BorEco BA212E will be the reference material for Krah-production lines world-wide.

From left to right:
Alexander Krah , Jarmo Harjuntausta (Borouge), Heidrich, Mohana Murali (Borouge), Jochen Blickheuser

Sven Jürgens, James McGoldrick (Borealis), Katrin Stephan Füllgrabe

For more information about the material properties:

Borouge Pte Ltd, Sheikh Khalifa Energy Complex, Borouge Tower, Corniche Road, Abu Dhabi
Borealis Polyolefine GmbH, St. Peter Strasse 25, 4021 Linz, Austria

For more information about the production technology and the pipe properties:

Krah AG, Betzdorfer Str. 1; 57520 Schutzbach; info@krah.net

BorECO™ High Modulus PP (PP-HM) for sewer applications

Introduction

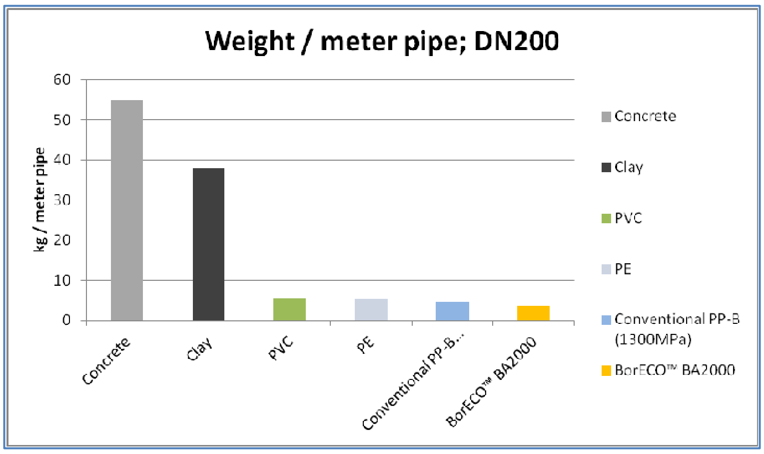
Polypropylene has an excellent track record after more than 30 years of service for non-pressure sewage and drainage applications. The inherent material properties and their development, energy and cost efficiency, pipe design and ease of manufacture and installation have contributed to this success. The traditional cornerstones of the requirements profile such as impact resistance, stiffness and chemical resistance are increasingly being supplemented by demands for purity, sustainability and recyclability. Consequently, the continuous development seen in both material and pipe design has brought additional benefits to pipe producers and end users and is contributing to a more sustainable environment.

The first generation of PP with higher modulus PP was introduced in 1998 and provided a major step forward with an optimized balance of the stiffness-impact properties. A few years later, this product was improved and an E-modulus of 1700 MPa was achieved, representing the first PP-HM to meet the requirements set in the modified EN1852 standard in 2002 (which was adjusted based on the development of this new class of polypropylenes). The journey has continued and recently, the next generation PP for underground drainage and sewage has been introduced. It presents the first and unique 2000 MPa PP-HM from Borealis – BorECO™ BA2000, achieved without the use of fillers, meeting and exceeding the requirements set in the recently - again - modified EN1852.

What is High Modulus PP (PP-HM)?

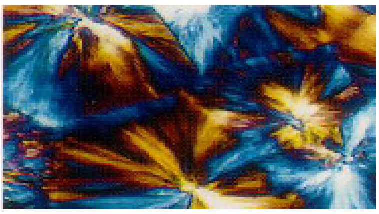
High-Modulus PP is a material with increased stiffness while keeping a good impact performance, allows for further down-gauging of the pipes, thus making a significant contribution to sustainability, thanks to less material consumption, lower pipe weight, lower transportation costs and faster installation.

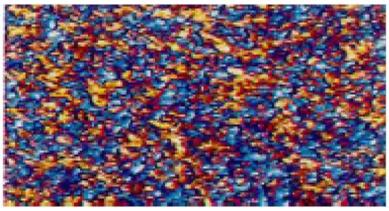
With regard to the amount of material used for underground drainage and sewerage, PP pipe systems have the lowest weight per meter pipe of all conventional and standardized materials for the application.
The nominal weight per meter of a solid wall DN200 mm conventional PP-B pipe is 4.65 kg and a corresponding PP-HM 2000 MPa weighs 3.77 kg/meter. For a concrete pipe with the same diameter the weight is around 55 kg per meter, i.e. approximately 15 times heavier!



The stiffness (modulus) and impact strength of BorECO™ HM-PP materials is maximised in the following ways:

1) by **increasing the crystallinity** level of the semi-crystalline polypropylene material
2) by **nucleating the crystals** in order to obtain many small crystals rather than few large crystals
3) by **optimizing the level of the comonomer/EPR** phase contained in the PP.
4) by obtaining a **fine dispersion of the comonomer/EPR** phase in the PP.


Non-nucleated PP crystal structure


Crystalline structure of BorECO™ PP

The ideal material therefore for such an application is one which exhibits the combination of the having a low density (or high specific volume) and a high stiffness.

The following table compares these characteristic data for the most commonly used plastics material in non-pressure sewer applications.

Material	Density (kg/m3)	Specific volume (m3/tonne)	Tensile modulus (MPa)
BorECO™ PP	900	1,10	up to 2000
Standard PP(-B)	900	1,10	1300
HDPE	960	1,04	1000
PVC	1400	0,71	2500

The following table demonstrates clearly what the combination of low density (high specific volume) of the material in combination with the high stiffness of the High Modulus PP materials means in terms of the meter weight of waste water pipes.

DN/OD	S13,3 (PP-HM) Wall thickness	kg/m	S 11,2 (PP-B) Wall thickness	kg/m	S10 (PE)	Kg/m	S16,7 (PVC) Wall thickness	Kg/m
110	4	1,20	4,7	1,40	5,3	1,64	3,2	1,64
125	4,6	1,57	5,4	1,83	6	2,11	3,7	2,16
160	5,8	2,53	6,9	2,99	7,7	3,46	4,7	3,51
200	7,3	3,98	8,6	4,65	9,6	5,40	5,9	5,50
250	9,1	6,20	10,7	7,24	11,9	8,36	7,3	8,51
315	11,4	9,78	13,5	11,50	15	13,28	9,2	13,52
355	12,9	12,47	15,2	14,60	16,9	16,87	10,4	17,22
400	14,5	15,80	17,1	18,50	19,1	21,47	11,7	21,83
450	16,3	19,98	19,2	23,37	21,5	27,19	13,2	27,70
500	18,1	24,65	21,4	28,94	23,9	33,59	14,6	34,05
630	22,8	39,12	26,9	45,85	30	53,13	18,4	54,06
800	29	63,19	34,2	74,01	38,1	85,68		
1000	36,2	98,60	42,7	115,52	47,7	134,08		
1200	43,4	141,86	51,2	166,22	57,2	192,94		
1400	50,6	192,96	59,8	226,49				
1600	57,9	252,33	68,3	295,64				

Conclusion

The PP polymer development has supported the progress of plastics pipes both for solid wall and for structured-wall pipe systems and will continue to do so in the years to come, because we believe that there is still a high potential for development and optimisation in the areas of material- and compound development and in pipe design. It is well known that the development of PP-B and the high-modulus PP have contributed to an increased use and geographical spread of PP pipe systems. Future developments are expected concerning improvements in processability, and thus even further reduction of pipe weight per meter, and naturally to proceed in building on the sustainability benefits and lifetime expectancy with plastics pipes systems are the focus of development work.

The continuous efforts in PP development have also induced the development of new pipe designs such as the spirally wound pipe. The results of processing trials using the Krah spiral winding process together with BorECO™ PP materials, have revealed that this innovative pipe manufacturing process and this innovative material almost give the impression that they were invented for each other.

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ImProfil of:
Stephan Füllgrabe

10 Questions for Stephan Füllgrabe / Plaspitec GmbH

1. Since when do you work for Plaspitec?
I started in the middle of 2010.

2. What is your position in the company?
I am one of the owners and also Managing Director of the company.

3. What did you do before starting your job at Plaspitec?
Since almost 20 years I am working for the plastic industry (pipes, fittings, tanks, apparatus etc.)
I was working 8 years as managing director of the spiral pipe production factory "Frank&Krah" before I founded my own company "Xgenia" and started working with Plaspitec as consultant.

4. What are the characteristics of your company?
Experience and Knowledge about plastic and especially Krah pipe technology as the basis!
We are always endeavored to find the best solution for our customer. We are aware, that the solution for a successful business can be varying in different countries. The solution has to match to culture, infrastructure and to the general expectations.

5. What is your last development?
The welding rod production machine W35 for plastic fabricators. Every consumer of welding rod is a potential customer. The cost calculation is very interesting and convincing, especially in case the demand is bigger than 1000 kg per anno.

6. What is in your opinion, the most valuable competitive advantage of the Krah *Production Pipe Technology?*
Flexibility is the most valuable advantage and the key for success. With Krah Technology you are able to react immediately to any change of requirements you face.

7. How do you see the market for plastic pipes in the next 10 years?
The pipe market will increase further, even if through the worldwide economically concern we will see partially a decrease of the demand temporary. 3 reasons:

- *Too many areas in the world have still no access to potable water and are not connected to sewer system and water treatment plants.*
- *In already industrialized areas the requirements for renewing and renovation of old and damaged pipes are continuously growing – what is a very interesting market for plastic pipe with structured wall (relining).*
- *Privatization of water management pushes the attention of the life service time of the installed pipes. Depreciation and maintenance are responsible for almost 50% of the costs for a pipe system. Both factors can be affected by using high quality PEHD with life service time of more than 100 years. But even PP and other thermoplastic materials show a very good durability – specially against concrete, Polycrete, GRP etc.*

8. Where do you see yourself/the company in 5 years?
Increasing worldwide demand of plastic pipes open new chances for consulting and trading every day. Plaspitec will extend the product range, especially of welding equipment and accessories for pipe production. Consulting and know how transfer will be still the foundation of the company.

9. Please tell us more about your current most interesting project.
The most interesting projects for Plaspitec are at the moment in the Gulf Area and Eastern Europe. To see a factory which is doing well after start up like our customer "United Gulf Pipe Manufacturing, Oman" or "Krah Bahrain, Bahrain" is very satisfying.

Stephan Personal

Family:	I have a girl friend, three brothers and of course one mom and one dad.
In my spare time:	I work in my house and garden. Furthermore I try to spend time in the nature close to my home as much I can. I enjoy jogging in the forest and doing other kind of sports like …
I am just reading...	a book about renovation and modernization of old houses – important if you own a 60 years old house …
I can laugh about...	situation comedy and sometimes about my self ☺.
My favorite Food:	I like Italian food and prefer light meal but a nice steak is always welcome.
My favorite holiday destination:	I am travelling for business a lot, so I am very happy to stay at home or to be at the German Seaside.

For Large Diameter Plastic Pipes

The main task of pipe systems is to transport a medium in a safe way and without any leakage from one place to another. For polyethylene and polypropylene systems homogenous jointing connections are preferably used, as the sustainability and safety are guaranteed and they are maintenance-free as well.

Flange connections are also a very important jointing method within a pipe system, as they are a detachable connection and thus allow a transition to other pipe materials.

The main areas of applications for flange connections are:

- Connection to valves and shut-off devices
- Connection to other materials (e.g. steel)
- Connection to buildings
- Maintenance ports
- Pipe caps
- Connection to special parts and fittings

Integral type flange, made of polyethylene Helical Wound Pipe

Connection to steel line with PE-flange + Steel Backing Ring

The bigger the pipe dimension, the less standard flanges can be found on the market. The pipe producers design the flanges professionally according to the state of art and according to the existing norms and guidelines. For pipes made of thermoplastic materials, DVS 2205 part 4 is often followed based on the AD instruction sheets B7 and B8.
Furthermore the most relevant norms provide an orientation regarding the selection of the screw quantity and the general dimensioning. Typical norms for steel flanges are, among others:

- ANSI/ASME B16.5 Class 150
- ASTM D 4024
- DIN 2673
- EN 1092

The relevant flange norms have been included for small and middle-sized diameters also in the classical plastic norms for fittings, as for example in DIN 16962 / DIN 16963.

On the basis of all these information an initial assessment regarding the dimensioning can be done. Especially regarding flange thickness, contact area, gasket etc. should be taken into account.
Before starting with the actual calculation it is helpful to make a scale drawing in order to illustrate better the proportions.

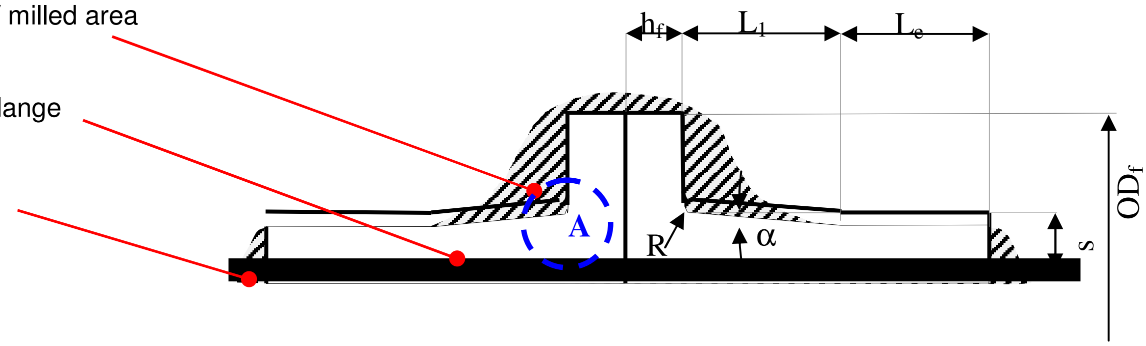
The production procedure of the flange is also very crucial for the dimensioning.
Homogenously produced flanges on basis of molded, wound (helical extruded) or axially-extruded semi-finished parts are preferable compared to welded constructions.
Especially for large diameter pipes the production should be carried out on a homogenously wound form and should be later machined by milling process in order to get the required shape. Thus, no extrusion seams are necessary which positively improves the strength property. The blue marked area „A“ in the sketch below is mostly loaded by bending moment and especially to be considered.

Flanges made out of a wounded pipe
(homogenous construction):

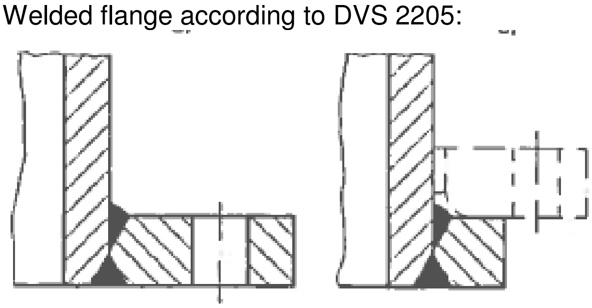
machined / milled area

Resulting flange

Mandrel



Welded flange according to DVS 2205:



Loose-type flanges are usually built as follows:

- Stub-end made of polyethylene or polypropylene
- Loose-tpye flange made of metallic material (optionally coated with plastic) or fiber-reinforced plastics (FRP)

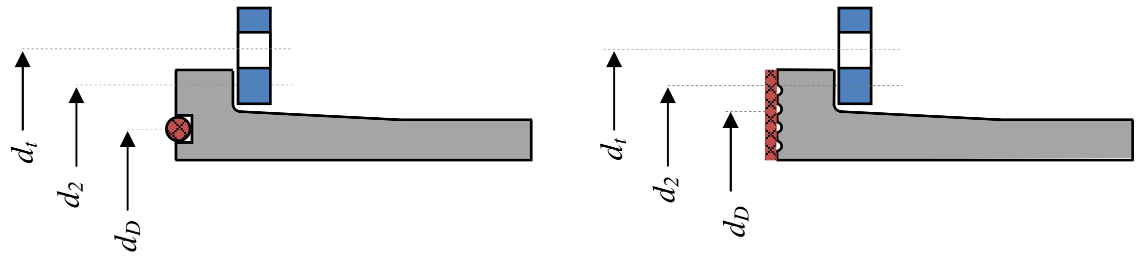
Backing rings made of steel or glas fibre are often used with integral flanges due to the creep behavior of thermoplastic materials and the relatively low elastic modulus to improve the load distribution and the associated load. Thus a decoupled load situation is created and the advantages of the respective materials can be benefited from.

The choice of sealing material and the sealing geometry is also very important. O-ring sealings have proven themselves for plastic flanges or flat sealings/gaskets in connection with profiled surface of the stub-end. Both serve to improve the sealing effect by partially increasing the surface pressure.
Elastomer materials are principally used as sealing material – the preferred hardness generally is approx. 50-70 Shore A. When choosing the sealing material also the thermic and chemical resistance. The properties of the sealing (hardness, flexibility, etc) have a direct influence on the necessary tightening torque for the screws, just as friction and greasing between screws and nuts.
Typical values for sufficient tightening torque for M16 are for example 50 Nm...

Schematic drawing

a) O-Ring

b) Flat sealings/gaskets with profiled surface of stub end



Dimensioning of the screws:

For plastic flanges the medium distance between screw holes should not be bigger than 80 mm or 5 x diameter of holes. During the calculation it always has to be distinguished between the operating condition and the installation condition.

The surface pressure between lose flange and bund should not exceed the permissible value of thermoplastics. The same applies for the backing flanges at integral flange connections.

The necessary bolt force for flat sealings during operation is calculated as follows:

$$P_{SB} = \frac{p}{10} \cdot \left(\frac{\pi \cdot d_D^{\ 2}}{4} + 3{,}8\, d_D \cdot k_1 \right)$$

PSB = screw force during operation [N]
p = working pressure [bar]
dD = middle diameter of gasket [mm]
K1 = gasket characteristics DVS 2205-4 (material and medium - dependent) [-]

As general rule for rubber gaskets, the screw force in operation is higher as in the installation situation, however this should always be tested according to DVS 2205-4.

For O-ring sealings the position of the o-ring is crucial, resulting the formula. The groove for the O-ring should be positioned close to the pipes wall.

For integral flanges:

$$P_{SB} = \frac{p \cdot \pi \cdot d_D^{\ 2}}{40} \cdot \frac{y_1}{y_2}$$

for stub ends

$$P_{SB} = \frac{p \cdot \pi \cdot d_D^{\ 2}}{40}$$

Y1 = distance between outer diameter of flange and medium diameter of pipe
Y1=(ODf – ID – s)/2

Y2 = distance between outer diameter of flange and medium diameter of screw hole circle
Y2=(ODf –dt)/2

Dimensioning of stub end and integral type flange

The required height of stub end and integral type flange is calculated by the maximum bending moment of inertia. The moment of inertia can be calculated according following formulae

$$W = \frac{P_{SB} \cdot A_2 \cdot A_4 \cdot S}{K_{(A_1, A_3)}} \cdot a$$

K = allowable strength acc. creep rupture curves (depending from time and temperature)
A2 = reduction factor for chemicals acc. DVS 2205
A4 = reduction factor for specific strength acc. DVS 2205
S = Safety factor

The height itself can be calculated as follows:

for stub ends

$$h_f = C \cdot \sqrt{\frac{C_1 \cdot W}{d_2 \cdot \pi}}$$

for integral type flanges

$$h_f = C \cdot \sqrt{\frac{C_1 \cdot W}{d_t \cdot \pi - n \cdot d_L}}$$

hf = Thickness flange (stub end)
C = for homogenously stub end and flanges = 0,9
for welded stub end and flanges = 1,1
C1 = for homogenously stub end and flanges = 2
for welded stub end and flanges = 3
d2 = medium diameter of contact between flange and stub end
dt = diameter screw hole circle
dL = diameter holes for srews

Furthermore should be considered:

- the angle should be ca 15°
- the length L1 should be > hf
- at the transition from flange to pipe wall always a sufficient radius should be considered (depends from diameter, typical values R= 5 until 10 mm)

Of course there are more details for an accurate flange design than shown in this short excursion. The most accurate results and even applicable for more complex design you can find by using finite element calculation!
For more information please don't hesitate to contact us, we provide Engineering and Consultancy for plastic pipes Systems!

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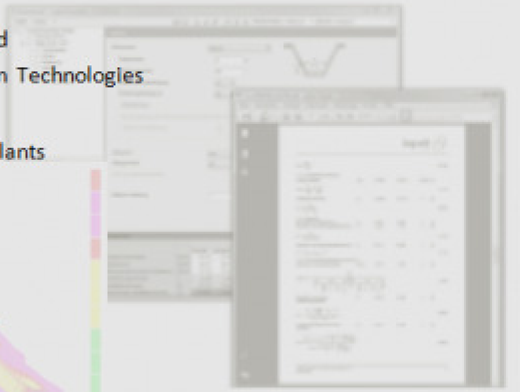
Companies introduce themselves

1. Plaspitec GmbH

PLASPITEC
plastic pipe technology

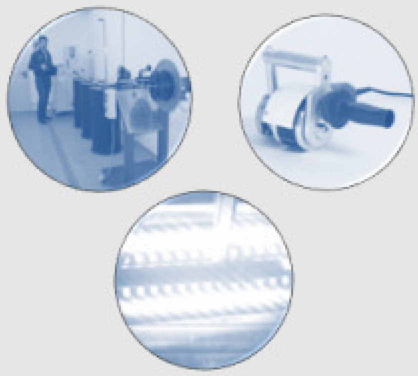
We are providing Consultancy, Engineering and Interims Management for Krah Pipe Production Technologies



- Training of local Management
- Interim management for production plants
- Analyzing of work flow and organizational structure
- Feasibility studies
- Technical presentations
- Engineering and static calculations for Plastic Pipe Applications
- Project management for Pipe Projects

Furthermore we offer you in our shop:

- Welding Rod Production Lines
- Welding Rod (PE and PP, ∅ 3, 4 and 5 mm)
- Plastic Welding Equipment
  - Hand Welding Extruder
  - Electro fusion Boxes
  - Tools and Accessories for Welding
- Infrared Lamps and IR-Technology
- Hand-held-equipment like our “profile remover” and many other things



For more information, please do not hesitate to contact us

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2. G & S Plast GmbH & Co. KG
NEW PLAYER in the corrugated pipe business

Two former Fränkische Rohrwerke employees founded their own company.

In the beginning of April 2010 Reinhard Gruber and Joachim Schuster have founded the company G&S Plast GmbH & Co. KG, located in Haßfurt – Germany.

Reinhard Gruber was working for Fränkische Rohrwerke for 17 years in the sales division for corrugated pipe production lines; from 2007 to 2009 he was Sales Director for the machinery division.

Mechanical engineer Joachim Schuster was working for Fränkische Rohrwerke for 16 years. During this time he was the head of the engineering shop, where the corrugated pipe production lines have been built.

The straight forward company with its growing philosophy was already fruitful by designing their first corrugator GSC 100/70. The GSC 100/70 has been especially developed for the production of core tubes with a diameter range from 20 – 100 mm and is producing already successfully.

Because of its high flexibility this corrugator is perfectly compatible for the spiral winded machinery made by company KRAH.The profile geometry of the core tubes has been developed in such a way, that they reach a high pipe stiffness at low weight per meter. Thus they are a suitable completion to the high quality production lines of company KRAH.

G & S PLAST offers their customer a maximum of competence. Our customers are always in the center of our interests. The success of our young company is based on an excellent cooperation between regular customer, new customers and the supplier.
We are acting worldwide; please contact us to get convinced by our service and experience!