

# IMPROFIL



**Thermoplastic manholes**  
for and out of large diameter pipes



**ImProfil of:**  
Mohammed Al Hashani / UGPM



**Mixed water pipeline**  
with dry weather channel

**See also:** **Why should you** design, use and produce KRAH Pipe System for pressure- and gravity applications?  
**The Azerbaijan Project** from the idea to the finished pipe  
**ArabPlast 2013**

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

## Welcome to the New Year 2013

I hope you had a happy and successful start into 2013!

The plastic pipe industry began this year with the important exhibition "ArabPlast 2013" in Dubai.



Since we presented our company there, we could experience lots of new things during the time. All about the activities and the ambiance during the show are described in this first edition of our newsletter. As we would like to continue this good start our New Year's resolution is it to publish as many technical newsletters as we can. Therefore we will happily receive your subject proposals or finished reports which will then be published in one of the next issues.

Additionally a couple of interesting reports about the application of the KRAH Pipe System are published in this issue. One of the articles, for instance, tells you a story about manhole fabrication in Sultanate Oman. Another article will give you an idea of how to enrich large diameter pipes with dry weather channel.

Moreover, we have prepared you a report about all the advantages and reasons for using, designing and producing Krah pipes system as well. On special request we will also summarize you all the advantages in details.

Last but not least an interview "10 questions for ..." with our long-term partner Engineer Mohammed Al Hashani from Sultanate Oman is attached in this edition that might be interesting for you.

I hope you will enjoy this issue of Improfil.

With kind regards

**Alexander Krah**  
CEO of Krah AG

# IMPROFIL

## Thermoplastic Manholes for and out of Large Diameter Pipes

### Introduction:

Manholes are, beside pipes and fittings, an essential element of underground pipe-systems. They are used for maintenance and inspection of sewers, sampling point or are fixed part of process technology / fluid engineering. The fabrication of thermoplastic manholes can be done in different ways of production. While, in smaller dimensions ( $DN \leq 800$ ), blow molded, injection molded or rotation molded manholes are in the market, manholes made of profiled pipes (helical extruded pipes) and semi-finished products will be used in medium sized and large diameters (DN800 to DN4000). Especially, the materials Polyethylene (PE) and Polypropylene (PP) are popular, due to their very long service life ( $> 100$  years), good flexibility, high impact resistance, high strength, safety and low weight.

The authors of this report have large experience in the production and application of plastic pipes in the Sultanate of Oman. The Sultanate of Oman is well known for the high investments in the build-up and renewal of the infrastructure. Consequently, high quality materials will be used which high safety and guarantee a maximum service life. This has a direct implication in the use of very high quality-standards and specifications for testing during the production of large diameter manholes, which are more stringent and comprehensive than those used in many European countries.



Pic 1: PE100-Manhole for Sewer DN1600/1200  
(Source: UGPM, Sultanate of Oman)

### The static design and structural static calculation

The static design of manholes has to always consider the intended application or in the case of standardized shape of manholes, the maximum load. Thereby following parameters influence the design:

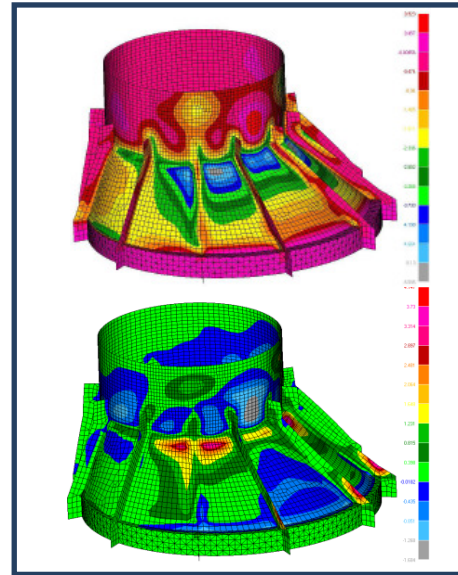
- Depth and ground water level
- Soil conditions and proctor density
- Trench (shape and back-filling)
- Traffic load and other external loads

The static calculation follows respective standards and specifications. Apart from ASTM F1759 the preferred standard is ATV A127. Even though ATV A127 was not originally developed for design of manholes, but the static proof by using this standard is accepted as one of the most detailed and precise way of static calculation worldwide. The situation and relation of load transmission and load distribution in the soil is defined very accurately in ATV A127.

# IMPROFIL

The market offers software solutions for easy and quick static calculations following ASTM F1759 or on the basis of ATV A127. Due this automated static calculation, a quick review is also possible to check changes in any parameters. For special cases and for non-uniform shapes of manhole shafts (e.g. eccentric cone with external or internal supports) a more detailed static calculation by using Finite Element Method is recommended. The FEM can be an important element to improve the design and to reduce material costs.

Another essential basis of calculation is the proofed short-term and long-term mechanical properties of the used material for the manhole. The suppliers of raw material continuously test the properties and document the results in appropriate factory released certificates.

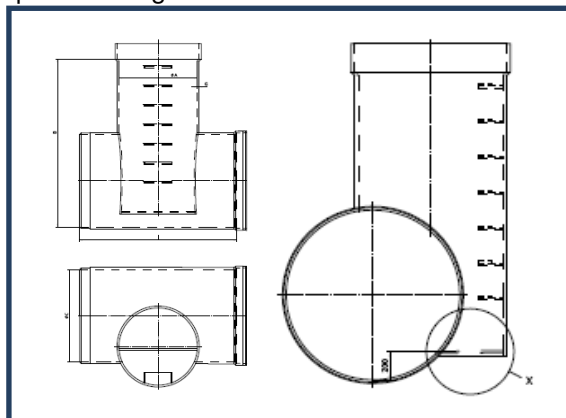


Pic 2: FEM Analysis for PE100-Manhole-Cone  
(Source: UGPM, Sultanate Oman)

According to their guaranteed long term-strength, thermoplastic materials can be rationed amongst others acc. DIN EN ISO 12162 in MRS-Classes (Minimum Required Strength). The designation "MRS 10" means a guaranteed strength of 10 MPa at a temperature of 20°C and load duration of 50 years. Furthermore, and within the scope of internal quality control, the manufacturer of pipe and manhole has to test for the dimensions of essential material properties (strain, strength, stiffness etc.)

A static calculation is dependent on the accuracy of the given parameters and values for the environment and operation. Pipe, manhole and soil are composing an interactive system. The soil itself has an often underestimated influence to the static of the total system. Non-cohesive soil and good compaction in layers below and around the manhole are always a well pre-condition for high static load capacity for the whole system of manhole and soil.

The more information the manufacturer/designer of the manhole has, the more detailed and accurate the calculation can be done. A detailed static calculation can discover possible savings, but the specific design rules for the material itself must always be considered. A design for a stiff concrete manhole should not be transferred to a design for flexible thermoplastic manhole without appropriate changes.



Pic 3: Sketch of a tangential manhole with benching

Often a simpler, better and more efficient design can be developed, because of the possibilities in joining (welding), profiled wall structure, lower weight, high impact resistance and flexibility. A very good example, in Europe, is the widely used tangential manhole, which is actively integrated into the pipe system. The installation time can be reduced and the diameter of the shaft can be reduced, and a cone is usually not necessary. This will save a lot of money and the manhole fulfills the same requirements.

# IMPROFIL

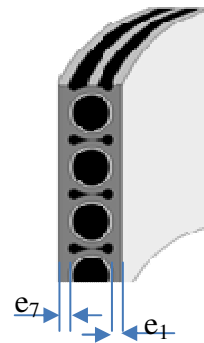
At the end of static design calculation, we obtain the required and necessary geometric data for the wall structure of the manhole and the bottom.

For manholes, along with the ring stiffness, the axial load capacity is also important. Especially with high depth, disadvantageous soil and installation conditions and high traffic load, the design is affected by axial load capacity. The axial load capacity is more or less proportional to the axial area. The axial area is the projected area in axial direction of inner and outer continuous wall thickness.  $A_{ax} = \pi [(OD - e_7) \times e_7 + (ID + e_1) \times e_1]$

Because of the production technology used for large diameter manholes (helical extrusion process) the wall thicknesses can be changed and optimized very easily. Even for a single pipe (shaft), the wall thickness or the profile can be changed easily. With helical extrusion it is possible to produce a tailor-made design of the shaft regardless of higher loads close to the bottom area due to radial buckling of ground water table or other loads.

Important geometric data of wall structure:

- Moment of inertia
- Inner section modulus
- Outer section modulus
- Inner wall thickness  $e_1$
- Outer wall thickness  $e_7$
- Cross section areas



Picture 4: Sketch profiled wall structure

## The production and structural shape

The shaft for large diameters is normally produced in one shot. The production process (helical extrusion) is fully automatic; the machine will be programmed by operator before starting. The parameters will be documented for a complete quality-chain. At UGPM in the Sultanate of Oman, the manholes are produced exclusively out of raw materials category PE 100 (MRS 10) or high stiff Polypropylene Block-Copolymer. The shaft with smooth inside & smooth outside surfaces are normally produced as profiled pipe; solid wall pipes are produced only for small dimensions  $\leq$  DN800. The profile height and wall thicknesses depend essentially from static design, but the minimum required wall thicknesses acc. DIN 16961 and EN 13476 and minimum Ring stiffness of SN2 acc. EN13598 must be considered also.



Pic 5: Fabrication of PE100-Sewer Manhole at UGPM (DN1600/1200, with cone, height 3800 mm)

If a diameter reduction is favored for the riser, the necessary cone is produced out of prefabricated pipe-segments. The supports to avoid radial and axial buckling should be calculated with FEM to guarantee the required long-term-stability. The necessary joints between supports, cone, riser and shaft are executed as "Extrusion welding" or if possible by "Heated Tool-Welding" under consideration of DVS-rules (DVS 2205, DVS 2207)

# IMPROFIL

The bottom of the manhole including benching is fabricated out of extruded sheets acc. EN ISO 1872-1 or pressed semi-finished products. Pipe connections and the channel are fabricated by using extruded pipes according EN 12201 or EN 13476. For all components and assemblies (manhole shaft, bottom, benching, channel, pipe nozzles etc.) the same quality and category of raw material should be used. If favored, the benching, can be manufactured out of sheets with Anti-Slip-Properties acc. DIN 51130 for application in work areas (e.g. Type Plaspitac PE100 AR). These sheets are surface-treated and must be prepared mechanically in the joining area before welding.

Generally, the weld-ability has to be guaranteed by the fabricator. If the fabricator use different types of polymer (e.g. PE80 + LDPE), the fabricator of the manhole has to document the weld-ability by proof of the short- and long-term welding factor and by proof of bending angle at welded joints (DVS 2203-2,-4 und -5).

If Manholes are affected by ground water (short- or long-term) the static design must contain a calculation for buoyancy. The buoyancy-safety can be achieved through different kind of design-shapes. The choice depends upon the situation at the installation site and on the final application of the product:

- Anti-floating-collars  
either homogenously integrated by helical-extrusion during production (outside profile) or afterwards joined by extrusion welding.
- Concrete-ring wall above the stuck-out bottom of the manhole
- Negative buoyancy by using double bottom with concrete-filling filling procedure at site through re-sealable opening in the benching
- Anchoring with foundation, where required with steel-reinforcement

The Negative buoyancy, by using double bottom with concrete-filling, has the additional advantage, that the pressure-load by groundwater will be kept away from inner bottom. The welding joint is not loaded by strain and bending of the bottom will be avoided.

## Quality Control

For manholes fabrication, the same quality standards have to be considered as in the production of pipes and fittings. That mean, that all processes in fabrication, development and sales must be certified acc. EN ISO 9001 and quality control system must be implemented in all areas of the production. Regular internal inspection and testing in laboratory is an essential element for guaranteeing consistent quality of the final product. The most important test procedures for thermoplastic manholes are a part of the following standards:

- Ringstiffness test acc. EN 14982
- Vertical load testing at the finished manhole acc. EN 13598 / EN 14802
- Water Tightness Test acc. EN13598
- Stability of manhole bottom structure acc. EN 14830
- Strength and pull-out-resistance of ladder and steps acc. EN 13598
- Impact test at bottom of manhole acc. EN13598
- Test of welding joints acc. DVS 2203
- Melt index at finished product (EN ISO 1133)
- Testing of mechanical, physical and thermal properties of the used material

# IMPROFIL



Pic 6: Test of water tightness acc. DIN EN ISO 13598; 100% Control at UGPM,Oman



Pic 7: Test of vertical load acc. DIN EN ISO 14802 (special test set-up for large diameter manholes, not buried in soil-box, UGPM,Oman)



Pic 8: durability test acc. DIN EN ISO 14830 (vacuum test at 80 °C)



Pic 9: Test of structural integrity acc. DIN EN ISO 14830, vacuum test at 20 °C, free assembled test set-up

Although the manhole fabrication in large diameters becomes more and more automated, there is still a part of manual work which has to be considered in quality management. In the same way that machines are improved continuously, it is necessary, by internal and external training programs, to improve the quality of work and knowledge of each member of the production team.

Plastic welders should regularly join training courses to improve their hand craft and to implement new knowledge into the work-flow. External consultant or independent plastic institutes can provide possibilities to pass exams acc. DVS 2212 and to attend seminars acc. DVS 2281 /2282. Between the fabricator and the customer, the qualification of the welder and the relevant certificate should be agreed. Welding joints should be marked durable by a stamp to guarantee traceability in the same way as required for manhole shafts.



Pic 10: Traceability code at welding joints, stamped welding seam, UGPM, Oman)

# IMPROFIL

## Conclusion and future prospects

Thermoplastic manholes for large diameters are more than an alternative to other materials. Because of the flexibility in helical extrusion production and the excellent material properties, unique technical solutions are possible. Thanks to high flexibility and strength, high chemical resistance against multitude of acids and bases, the undoubted durability and the excellent weld-ability of the selected raw material, an increased number of designers and customers prefer thermoplastic manholes, including for large dimensions. Pipes, fittings and manholes compose a homogeneous system, joined by standardized welding procedures.

The already existing test standards for manholes are a good basis, if they are implemented in the quality-system of the manhole fabricator. But for large diameters the standards could need some additions and improvements to make the standards more applicable. Specifically, the test procedures must be adapted for large diameters and lengths. The special design and the higher installation depth for large diameter manholes should be considered more in the testing standards. Large diameter thermoplastic manholes are standard used for depth until 10-15 m (In landfills even until 50 m). Fabricators of large diameter manholes have already implemented a higher quality level than in the standards mentioned!

Essential for a consistent high quality is beside qualified materials, modern and automated production and following the test procedures also completes the quality chain, where the manual work is considered in the same fashion. Training courses for welders and external inspection of the manufacturing process are important to guarantee a end product of consistent quality.

New developed production procedures, high grades of automation and improved properties of the raw materials are continuously expanding the possibilities of application. New thermoplastic materials, like e.g. the short-fiber reinforced thermoplastics show 2-3-times more stiffness and strength in comparison with non-reinforced materials and indicate that further investment and implementation of these technologies is maintained.

## Authors:



Eng. Mohammed Al Hashani  
Managing Director  
United Gulf Pipe Manufacturing Co.LLC  
Sultanate of Oman  
*UGPM is one of the leading producer of thermoplastic pipe systems in Middle East  
Diameter range: 40 mm until 4000 mm*



Dipl.-Ing. Stephan Füllgrabe  
Managing Director  
Plaspitec GmbH  
Cologne, Germany  
*Plaspitec is an international operating Consulting and Engineering Company for Large Diameter Plastic Pipe Systems*



**IMPROFIL**



## **ImProfil of: Mohammed al Hashani**

10 Questions for Mohammed al Hashani / United Gulf Pipe Manufacturing

**1. Since when do you work for “UGPM“**

*(United Gulf Pipe Manufacturing, Sultanate of Oman)  
Since June 2009*

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

*I am the Managing Director*

**3. What did you do before starting your job at UGPM?**

*I was working in FPS international Group of companies as a head of water treatment department and a vice president of KRAH Middle East*

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

*We entered to a strong market since KWH Technology is there for more than 10 years, within 2 years we became the leaders in this market in regards to gravity applications ( pipes manhole and other accessories)*

*This is all because we decided that we will use the highest quality material available in the market and we will concentrate on improving our quality and laboratory.*

*We have got the ISO 9001 FOR QUALITY 14001 AND ISO 14001:2004 & OHSAS 18001:2007 AND OTHERS.*

**5. Since when UGPM is working with the Krah technology?**

*SINCE 2009*



# IMPROFIL

**6. Which Krah machines does UGPM own until now?**

*KR 700 AND KDR 700*

**7. What do you call your „Krah pipes“? (brand name)**

*UGPM KRAH Pipes*

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

*Its an engineering machine you can design your profiles according to the application.*

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

*We will be covering hopefully all the sultanate of Oman.*

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

*Qurom & lallam it's a very importen project in muscat since its in the area where VIPS are there, using our HDPE (PE 100) manholes and HDPE (PE 100) House connections Will be the only way to complete this project by the CCC Contractors because of the easy handling and installation.*

## Mohammed Personal

Family: I am married since December 2010, I have a beautiful wife and baby girl called Laura borned in 20.02.2012.

In my spare time: I play football and become interested in Golf

I am just reading... I read anything related to economy and industries.

I can laugh about... My baby when she starts trying talking

My favorite Food: Pepper Steak

My favorite holiday destination: Westerwald in Germany

# IMPROFIL

## Mixed water pipeline witch dry weather channel

The town „Rasseln“ wich is a part of the city Mönchengladbach in Germany wasn't connected to the sewage network until 2011. The used water had simply been let seep away, which is not permitted.

The NVV (Niederrheinische Versorgung und Verkehr AG), which is responsible for the proper disposal of any sewage, planned the construction of a large mixed water channel. The project consisted of building a large storage channel and pipelines to connect the town of "Rasseln" to the sewer system of the city of Mönchengladbach. In Rasseln sewage water runs into a pumping station and via two pressure pipes into the sewer systems of Mönchengladbach.

To solve this challenge two options were possible:

1. rectangular concrete channel with lining and a dry weather channel
2. Retaining channel of PE consisting of PE- buildings and profiled pipes DN 2000 with dry weather channel



### Construction project in the focus of the public

Right from the start the project was in the center of public attention. For one the thoroughfare through the town is a major road connecting two important highways of that region, and two the residents had to take on responsibility for a share of the cost of the connection onto the sewage system: their part was to pay for the sewage pipe leading to the public canal, plus the parts needed to make the connection.

The company estimated that construction time would be about twelve months and requested a full closure for the entire duration.

### Only the best is good enough

For these reasons it became apparent that a sewage system was required that could be installed as cost efficient and as quickly as possible. The problem of the limited access presented an additional challenge. Assessment and evaluation eventually led to the economically most interesting option. Low cost, the possibility of a fast installation and the durability of the product were the deciding factors.



# IMPROFIL

Structured pipes made from PE 100 DN 2000 with pre installed dry weather channel and a bench on both sides had been chosen.

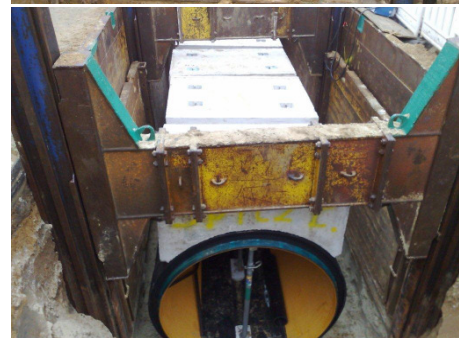
The pipes have an integrated electro fusion socket with a spigot and a light colored internal surface, with will facilitate future inspections. That has been manufactured in coextrusion. The pipes have a ring stiffness class SN8. As an additional advantage for an easier installation a pipe was chosen with smooth external surface. On account of the difficult condition of the surrounding ground it was impossible to use pipes exceeding a length of 3 meters per part/piece.

Backfilling was carried out with liquid soil, which led to increased strain during the period of construction, but by that way it was possible to minimize vibration shocks and to increase the speed of installation.

The safeguard them against buoyancy concrete weights were put on top of the pipes.

The fact that the pipes are equipped with a dry weather channel requires a hardwearing socketweld, therefore we chose an electro fusion socket. Crucial when using an electro fusion socket is the regulation of the welding process. The welding temperature needs to remain inside the optimum range throughout the entire procedure, no matter what the surrounding conditions are.

The control system must discern the present temperature of the environment and translate these into control signals accordingly. The automatic welding machine got all the relevant information concerning the welding process via barcode. Once the welding process is started the time and temperature required for welding are controlled automatically.



# IMPROFIL

## Success in all areas

The following characteristics had all parties involved convinced of the superior quality of the PE-system:

- optimum pipe stiffness through reinforcement with the profiles
- low weight makes for an economically sensible pipeline
- advanced hydraulic properties on account of the smooth inner surface and the preinstalled dry weather channel which reduce sedimentation, thus allowing for a lower gradient
- the light colored inner surface for uncomplicated inspections in the future
- connections that are safeguarded against root growth
- Self arresting sleeve spigot connection
- connections to transmit loads (axial and share force) and permanently leakproof
- Automatically controlled welding process that ensures welds of consistent optimum quality
- Welds that can be carried out by construction personnel without further training
- Not much time needed for executing the welds
- Fewer excavations are necessary for there's no need for extra holes under the socket
- Reduced overall cost for the pipe system



## And life goes on

Looking at this construction project it is easy to recognise that a pipe system in PE combines a technically advanced product with short construction time and makes sense economically as well. Permanently leakproof welds and an innovative process of pipe laying ensure a cost-optimized construction of sewage systems.

The fact that the PE pipe systems can be used for 100 years makes it possible to write off the costs over a long period of time, thus a sewage system can be cost-efficient. All these advantages are increasingly recognised by construction designers and clients – and residents are grateful.

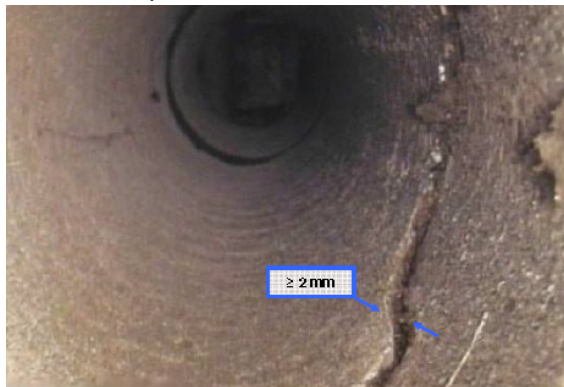
Contact Person:  
Mr. Andreas Wittner  
Henze GmbH, Troidorf  
a.wittner@henze-gmbh.de

# IMPROFIL

## Why should you design, use and produce KRAH Pipe System for pressure- and gravity applications?

### 1. Problems in existing sewage pipe lines

The Krah Pipe System has been designed to solve the major pipe failures in existing pipelines. According to a German study made by ATV the failures were divided into several sub-failures. But always the result was infiltration and exfiltration and the maintenance /repair costs are very high. As follows you will see here some photos of failures would NOT have happened, if the system was done with Krah-Pipes.



Crack formation of concrete pipe.



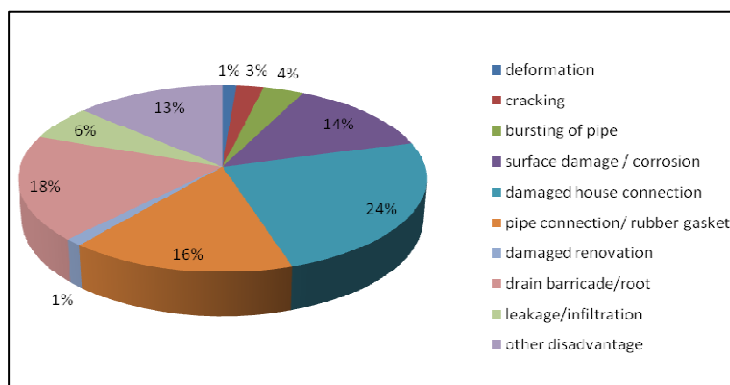
Complete pipe break of GRP pipe.



Growing roots after cracking



Internal corrosion in a concrete pipe



State of the sewer system in Germany to investigation of the DWA from 2009

In the today's design and choice of the products the later maintenance costs should be considered, so that the running costs will be low in the future.

# IMPROFIL

## 2. Gravity (up to 2bar) and Pressure Pipe System

Basically one production line of Krah can produce Krah gravity pipe system and also Krah pressure pipes with the same technology and same extrusion unit, by using a Comtruder®. The main difference between the two product applications is that the gravity pipe system is designed for high pipe stiffness to withstand an external load and the pressure pipe system a high internal pressure.

The Krah gravity pipes are produced with a structured (profiled) wall and they can be manufactured with a filler material, like calcium carbonate.

The pressure pipes are produced out of a compound (based on high density polyethylene and glass fiber) with a homogeneous solid wall.

An advantage of the Krah pipe system is the end finish of the pipes. Every pipe can be produced directly with an integrated socket and spigot or every end design which is available on today's market.

The pipes can be produced to meet the following standards:

Gravity pipes:

- DIN16961
- EN13476
- ASTM F894
- NBR7373
- JIS\_K6780

Pressure pipes:

- ASTM F2720
- DIN/SPEC 19674
- ISO/CD 29561

## 3. Material

Basically the following thermoplastic materials can be used

for gravity pipe application:

- Polyethylene (PE80 or PE100)
- Polypropylene (PP-R, PP-B or PP-H)
- Polypropylene with high stiffness (PPB-HM)
- Polyethylene or Polypropylene filled with calcium carbonate

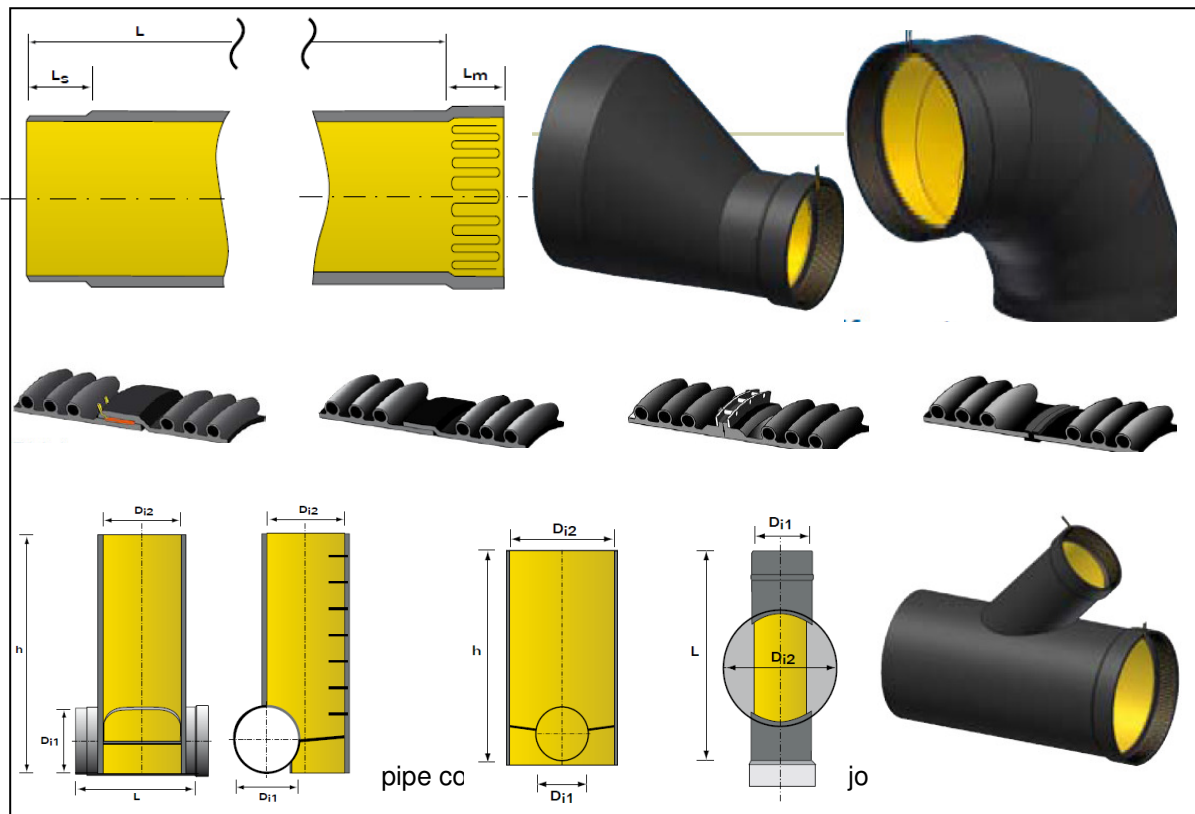
Pressure pipes are produced out of:

- Polyethylene (PE80 or PE100)
- PE100/fiber-compound (PE-GF)

# IMPROFIL

## 4. Wide product range

Beside the pipes with an internal diameter of DN 300 to DN 3.500 (for special applications also pipes up to DN4000 mm can be produced) the product range include all kinds of fittings, such as branches, bends and reductions as well as different types manholes, such as standard and tangential manholes with the adequate covers. Also included are special constructions like house connections and puddle flanges. All of these mentioned products are made out of solid wall Krah Pipes, therefore being an advantage for the jointing of the parts. The complete calculation and production technology can be provided by Krah as a one-stop-solution.



Krah Pipe System: selection of pipe components for a homogeneously joined pipe system

# IMPROFIL

## 5. No-Stock-Production

The production can be organized according to existing orders, because the setup time for a product change is very short (between 5-15min). So no big investment in a pipe stock is needed. The production technology follows the batch-production-principle.



Pipe on stock (DN1400- DN1800)

## 6. Tailor made pipes and fittings

Beside the standard stiffness (with a weight optimized structured wall) and pressure classes, tailor made pipes and fitting for all different requirements and applications for individual projects can be manufactured. By customizing the pipe products (especially in large pipe sizes and low quantities) the cost reduction effect is very high with the Krah-technology, because nearly every wall and material construction can be done.

So, no over-designing is needed, but the product will fit to the project as good as possible.

Detailed engineering and commercialization software is available.



Water retention tank during installation  
(pipes, manholes, fittings)



Profiled pipe joined with segmented bend (solid wall)



# IMPROFIL

## 7. Tailor made pressure rating

By using the Krah compound for pressure pipes, the minimum required strength (MRS) of the materials is 20 N/mm<sup>2</sup>. This is the minimum value of creep strength at a 50 year reference time and a temperature of 20 °C.

The safety factor (SF) is the ratio between the creep strength  $\sigma_c$  at given time and temperature and at a constant working stress  $\sigma_o$  and for fresh / drinking water application SF is 1.6.

Under internal pressure the pipe is subject to hoop stress on pipe wall.

$$\sigma_t = \frac{p \cdot D}{2 \cdot s}$$

$p$  = inner pressure  
 $D$  = medium diameter  
 $s$  = wall thickness  
 $\sigma_t$  = hoop stress

The calculated wall thickness can be produced with the Krah machine for every mandrel diameter. Actual limits in the wall thickness are 4mm (minimum) and 200 mm (maximum).

The main components of the PE-GF compound are:

20 %	chopped glass fiber
2 %	bonding agent
78 %	polyethylene high density

## 8. Life Time

Life expectancy is conservatively estimated to be at least 100 years, using the standard design basis, compared to conventional pipe materials that often only have a life expectancy of about 10 – 20 years.

Due to the special jointing method of Krah pipes with electro-fusion welding or extrusion welding, also the joints have a lifetime of 100 years.

Consequently the depreciation period becomes longer through the long lifetime of the piping and therefore the yearly depreciation rate becomes lower, which is another important economic advantage.

## 9. Pipe weight

The weight of Krah Pipes is one of the major advantages compared to conventional pipe materials, being determined with:

0,955 kg/m <sup>3</sup>	for polyethylene gravity pipes.
0,905 kg/m <sup>3</sup>	for polypropylene gravity pipes
1,140 kg/m <sup>3</sup>	for polyethylene gravity pipes, filled with 25% CaCo <sub>3</sub>

This extremely low weight therefore allows a much easier and quicker installation of the pipes, as in most cases no heavy machinery is necessary for the installation and handling of the pipes. Most of the handling can be done by a usual excavator on site.

# IMPROFIL

## 10. Homogenous piping

All Krah pipes and fittings are made of the same material and joined to one homogenous pipeline. Not even the connections between the components (like pipe and fittings) pose a weak point of the piping as they are joined by the electro-fusion method and therefore becoming a 100 % permanent tight joint. Due the welding ability of the material, repairing of the Krah pipe system is easy and will set back the repaired part into its original condition.

## 11. Flexibility

Buried pipe systems are subject to different and changing stresses. Sewer pipes are still in use, which have been installed over 80 years ago. Traffic and earth loads, affecting the system at that time can no longer be compared with today's concentration of traffic and superstructures. Loads that will influence pipelines in 50 years can only be estimated.

Therefore, it is very important to develop pipe systems which will adapt to the future stresses and will not break down under these loads.

So, why should not a pipe be used that gives way to the loads by deforming up to the point where the loads are minimized?

Flexible pipe systems allow the tensions within the material to be reduced. The danger of overstraining and thus of a fracture is eliminated. When the load decreases, the KRAH pipe can reach its new lowest-stress shape due to its elasticity. KRAH pipes have integrated deflection zones.

⇒ Flexibility can be equalized with resistance against overloading.

Due to its flexibility the pipe can also be bent to a certain extent so that some fittings needed for rigid systems can be saved. The recommended Bending radius is

for Krah sewer pipes:

$$r = 30 \cdot DN/ID$$

for Krah pressure pipes:

$$r = 100 \cdot DN/ID$$

Because of the spiral-wall-construction the pipe is flexible and still has an axial flexibility – which is very helpful for good and quick installation of sewage pipes, by considering the spring line.



Bending test, profile-pipe



Flexibility test

# IMPROFIL

## 12. Earthquake resistance

Even in areas, which are highly affected by earthquakes, Krah pipes are hardly damaged in comparison to pipes made of other materials.

The flexibility of the PE-material allows a deformation without breaks or leakage. More detailed information on the results of earthquakes and Krah pipe system is available.

## 13. Minimum (waterway) wall thickness

In comparison with most of the other pipe materials, it is possible to produce comparatively low-weight pipes with the Krah System, which at the same time satisfies all today's requirements for sewage piping.

However the pipe shall not only have the right stiffness needed for bearing the load of the soil and the traffic while installed but pipes also suffer multiple strains during transport, storage, installation operation and cleaning. Therefore, the pipe's waterway has to have a certain minimum wall thickness to bear all of these different strains. For the evaluation of the minimum waterway wall thickness different approaches were considered, taking into account all affecting factors, such as internal and external pressure, mechanical abrasion and penetration from the outside. Summing up all these impacts the minimum wall thickness of the waterway of profiled pipes can be calculated. A good proper waterway wall will give the pipe better properties for a long life time and can be used for hydro-jet cleaning without any common problems, like losing the water way wall.

Beside the profile that gives the required stiffness to Krah Pipes they also have a minimum wall thickness of the waterway in order to sustain all other strains the pipes are exposed to.

In case of low internal working pressure the waterway wall thickness can be adjusted according to this.

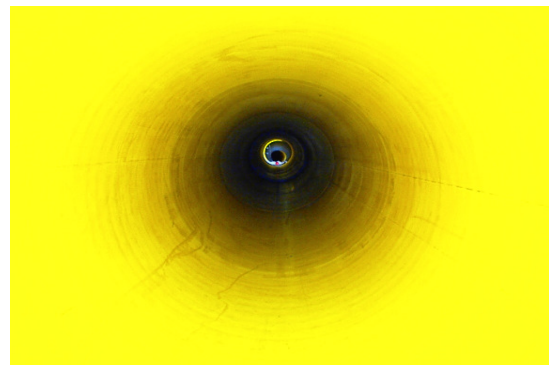
## 14. Support from the soil's carrying capacity

Rigid pipes have to bear the full carrying capacity of the earth loads. In case of Krah pipes, all loads are carried by the interaction of the flexible pipe and the compressed soil. By lowering the pipe crown, the load concentration above the pipe decreases. As a result of this "wanted" deformation, the spring line will be moved outwards. An additional bedding pressure sets itself, supporting the pipe laterally. The loads are balanced around the pipe by the deformation. For that reason, Krah pipes can also be used for big loads, without losing the advantages of its light weight features.

Since the pipelines are profiled on the outside, these profiles can fix the pipes in the soil. There will be no or very few axial extensions in the pipeline. Therefore, Krah pipes are nearly unaffected by temperature variations.

## 15. Inspection friendly

The bright colored inner surface is produced by co-extrusion, therefore being simultaneously extruded with the black outer surface. This bright color of the inner surface enhances the inspection of the piping. This co-extruded inner surface can also be done with an electro conductive material.



Bright inspection friendly inner layer

# IMPROFIL

## 16. Long laying length

Krah pipes have an installation length of 6 meters plus the integrated socket. Some other pipes out of conventional materials have shorter lengths and therefore need more connections.

⇒ The installation of Krah pipes hence is less time-consuming.

If needed pipes can be pre-welded and can supplied in length of 12, 18, 24 or 30 m.



Standard pipe length of 6m,  
with electric fusion socket and spigot end



prefabricated pipe length of 30m,  
with electric fusion socket and spigot end

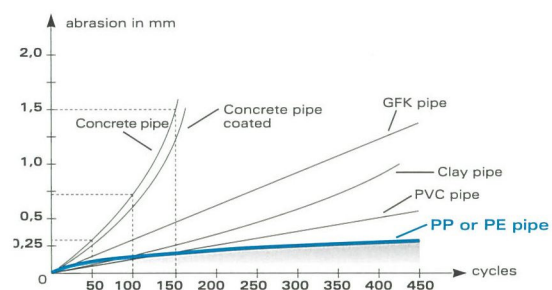
## 17. Long term hydrostatic strength

One of the outstanding engineering characteristics of Krah Pipes is their long term hydrostatic strength behavior under various thermal and environmental conditions.

## 18. Abrasion behavior

Krah Pipes are among the most abrasion proven pipes. This was tested in the so-called Darmstadt procedure and results are shown in the below diagram and confirm the quality of polyethylene pipes. Tests are performed at the "Süddeutsche Kunststoffzentrum" for its approval. It clearly shows that Krah Pipes made out of PE are in comparison with the other materials by far amongst the most abrasion resistant ones.

Abrasion resistance is especially important nowadays, where more and more solids are transported in the sewage.



Abrasion curve of various pipe materials according to the Darmstadt procedure

# IMPROFIL

## 19. Roughness

From a superior point of view the operational roughness value in ATV worksheet A 110 for all pipe materials, including plastic pipes, the losses resulting of wall roughness are determined uniformly with  $k = 0,1$  mm. Although, the natural wall roughness value of plastic pipes, which, according to all present experience are lower than those of the other pipe materials and also remain permanently steady, would have justified a better classification. The hydraulic dimensioning with the recommended global roughness therefore contains a sufficient safety margin for pipelines of plastic.1

The absolute roughness of plastic is between 0,0015 [mm] and 0,1 [m]2.

- ⇒ Due to this low roughness there is almost no accumulation on the pipe bottom for Krah pipes
- ⇒ Krah Pipes have the ability of "self-purification" (self-cleaning).
- ⇒ Low roughness has an important economic advantage as the maintenance expenditures are reduced to a minimum.

In consequence of the low roughness the hydraulic properties are improved and smaller diameters are required compared to conventional pipe materials with the same flow rate.

## 20. Hydraulic capacity (DN/ID)

The advantageous hydraulic properties of pipelines made of plastic pipes are considerably and effectively supported by the laying length and associated low quantity of pipe joints as well as well-formed fittings, which are therefore flow-beneficial.

Krah Pipes have excellent flow characteristics, especially compared to conventional materials. The nominal diameter is the inner diameter (DN/ID) and hydraulic properties of Krah pipes will remain constant regardless of the wall thickness, due to the smooth anti-adhesive inner pipe surface. The nominal diameter always corresponds to the respective inner diameter according to DIN 16961. Pipes with different pressure ratings or stiffness classes can be jointed easily.

## 21. Chemical corrosion resistance

Krah Pipes are highly resistant against aggressive chemical environments. Further it is externally resistant to aggressive soil (PH- value 1.0 - 5.0).

- ⇒ Krah Pipes are resistant externally and internally against aggressive chemicals.

Polyolefins have a non-polar molecule structure because they contain no double bonds. They also have a high molecular weight and therefore excellent resistance to chemicals and other media.

So, Krah Pipes are resistant to aqueous solutions of salts, dilute acids and alkalis. Electrochemical processes, which can lead to corrosion in metals, do not take place in Krah Pipes. Only strong oxidizing agents, such as highly concentrated peroxides and acids, or halogens attack Krah Pipes over a prolonged period of time. Especially concrete and steel pipes are very vulnerable to the aforementioned corrosive agents resulting in significant damages and failures of the system, whereas Krah Profiled Pipes are resistant from the inside and the outside.

## 22. UV-resistance

Commonly most natural materials and other plastics are degraded by weathering effects, particularly by the combined impact of short- wave ultraviolet radiation in sunlight and atmospheric oxygen.

- ⇒ Black polyethylene pipes are permanently resistant to atmospheric corrosion and UV radiation. Thus the pipes can be used and stored outside without the pipe material being damaged.

# IMPROFIL

## 23. Resistance to micro organisms, rodents and termites

The smooth round surface of plastic pipes does not give the teeth of rodent's sufficient hold to cause damage. Moreover, even in termite-affected countries no damage to pipelines made out of polyethylene by termites has ever been occurred. Polyethylene and polypropylene are not nutrient media for bacteria, fungi and spores.

- ⇒ The material of Krah pipes is resistant to all forms of microbial attack as well as both sulphurous acid and sulphates.
  
- ⇒ Assessments under food legislation:  
Krah Profiled Pipes are suitable for the transportation of mineral water. They have no tainting effect ("Extended quality test for mineral water compatibility", Institute Fresenius, Taunusstein, Germany.)

## 24. Jointing of Krah Pipes

Krah Pipes suit any kind of pipe connections, due to the properties of HDPE. All Krah pipes and fittings can be delivered with different joint systems, mainly determined on the basis of the application. The pipe ends are equipped accordingly and integrated directly in the pipe.

Basically, pipes and fittings made from polyethylene can be joined either by thermal or by mechanical systems and of course by electro-fusion. The most common method in the market for years has been electro-fusion, being the most favorable, simple and secure jointing technique.



Manual hand welding



Rubber sealing



Flanges



Butt-welding

# IMPROFIL

## 25. Integrated Electro-Fusion

KRAH has developed this technique also for large pipes. With this method the whole pipeline becomes a homogenous system and absolutely safe against wanted and unwanted in- and ex-filtrations.

A welding wire is included in the socket and then heated with the help of a special welding device, joining the two pipe ends (socket and spigot) together.

With this very quick jointing technique it is possible to install pipes in such a short period of time which has never been realized before. Also the necessary recording for quality assurance is realizable very easily and secure with the help of KRAH welding devices.

Generally the method of electro-fusion jointing has many advantages compared to other conventional systems. First of all, it is applicable for all diameters, small and large, with only one device and is available for a reasonable price.

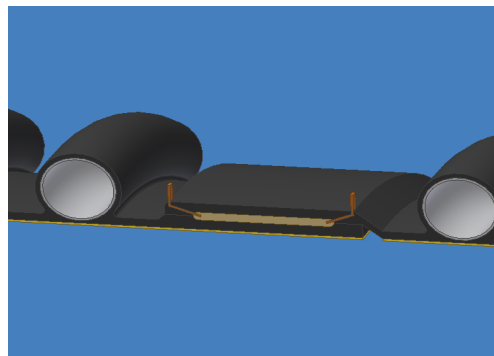
Further advantages are the short fusion time, installation in narrow trenches as no heavy, large equipment is needed and a fast installation of the piping by using several fusion devices at the same time can be carried out. The finished connection then is a 100 % permanent tight joint. Moreover, the fusion is possible from the inside when installing larger diameters. A welding record is printed and the electro-fusion device can be used again immediately, even when the pipe is still cooling.

Due to this connection method the piping becomes one homogenous piece that is adaptable to changes of the surrounding soil.

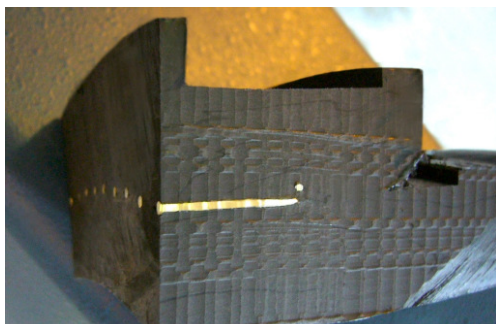
The electro fusion process is widely accepted these days, especially because of the relatively simple process and that this process is closely followed and monitored by well developed control boxes, virtually eradicating human error. The reliability of the electro fusion process is also shown by using it in the early days of gas and water distribution systems.



Electro fusion socket with heating wire



Schematic illustration of electro fusion joint



Sectional of electro fusion joint

# IMPROFIL

## 26. Main application

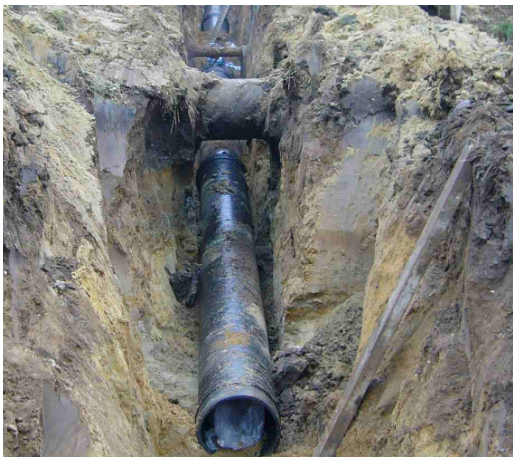
Due the manifold pipe and product possibilities the application field is huge and an investment in the production technology will be not build on one sales market. The main fields are:



Sewage pipe systems DN2000



Sewage Manhole



Potable water pipelines DN400 10bar



Outfall pipelines



Ventilation systems



Storage Tanks



# IMPROFIL



Drainage pipe system



Relining

## Summary:

The Krah-Pipe-System is a very feasible pipe technology for high quality products to be used under and above ground.

The system properties overcome all the existing pipe failures in the market. Today's needs for a sustainable infrastructure pipe system can be fulfilled by Krah pipes on a high economical aspect.

The design is easy, extensive design software is available or can be done by the standard design guidelines.

The pipe system considers all components and different jointing possibilities. The complete range of large diameters is available and can be supplied by one Krah pipe producer.

# IMPROFIL

## The **Azerbaijan** -Project - from the idea to the finished pipe- (a project study in 3 parts)

### Part 1: The Idea

The country Azerbaijan is located between the Caspian Sea and the Caucasus. Azerbaijan was part of the Sowjet Union until it has become independent in the year 1991. It is adjoining to Russia in the North, to Georgia in the North-West, to Iran in the South and to Armenia in the West. Further it has a common border with Turkey through the autonomous republic Nachitschewan. The capitol "Baku" is an important harbor city at the Caspian Sea. The total area of the country is 86.600 square kilometers. The national economy is still growing fast, Aserbaijan is rich in mineral sources, especially in oil and gas, but it has also a high agricultural potential. Only by need of renovation and repair of the infrastructure the further growing of the prosperous economy is limited.



Especially the underground infrastructure for the supply of potable water and for sewage-systems has to be renovated. The pipe-network has to be improved to achieve the whole population and to develop new areas. Plastic pipe systems are a very important element for this change in the Azerbaijani Infrastructure, for new pressure and gravity pipelines as well as for relining of damaged old pipe systems. One of the best arguments for plastic pipes is always the enormous life service time of 100 years. In small dimensions plastic pipe systems are already well introduced, but for medium and large diameter pipes the market demands urgently innovative plastic pipe systems.



Mr. Dr. Musayev, the general director of "STP - Sumgait Technologies Park" has recognized early the demand of large diameter plastic pipes and signed in 2012 the contract with Krah AG for the delivery of 3 Complete Production Lines for the diameter DN 800 until DN 3500. ([www.stp.az](http://www.stp.az))

2 Lines for Profiled Gravity Pipes made of High Density Polyethylene and high stiffness polypropylene (KR) and one line for pressure application of glas-fibre reinforced plastic and high density polyethylene.

Sumgait Technologies Park is located approximately 30 km from Baku and produce there already small and medium size diameters of plastic pipes. STP is the leading producer of direct extruded pipes for pressure application as well as corrugated pipes, but also have injection moulding and cable production facilities. With the Krah production machines for helical extruded pipes STP is finally entering the large diameter pipe market!

### Read in next Krah Newsletters:

Part 2: The start of production  
and Part 3: Pipe Installation

# IMPROFIL

## ArabPlast 2013

**DUBAI-** ArabPlast is the largest and most established trade fair for plastic and rubber industry in the Middle East showcasing wide spectrum of technology, machinery and equipments. It brings together leading manufacturers and buyers.

This year more than 900 international companies from 41 countries across the globe exhibited various disciplines of plastics, rubber and petrochemical industries during at this prestigious exhibition. In comparison with the last ArabPlast 2011, the quantity of visitors and exhibitors has recorded an increase of more than 30%. The largest number of foreign visitors came from Iran, Saudi Arabia, Oman, Qatar, Bahrain, Kuwait, Pakistan, African countries and India. But also more and more exhibitions and visitors from Europe, America, Asia and also Australia discover the importance of ArabPlast.

**Krah AG** - one of the world's leading suppliers of plastic pipe production technology was present at the ArabPlast fair and reported a high value of visitor who become interested in Krah Plastic



Pipe Production Technology. Mr. Bülent Kuzkaya from Krah AG and Mr. Mohammed Al Hashani informed visitors about the newest products of Krah AG. Especially production machines for very large diameters until DN4000, welding equipment and machines for manhole fabrication are requested. For the customer and visitors is very important, that with the Krah Production Technology both gravity and pressure pipes out of the new pipe-materials like

- High Stiffness Polypropylene e.g. BorECO BA212E from Borouge
- Glass-Fiber reinforced Polyethylene (MRS20) from Krah

can be produced!

The ArabPlast has become the key event for the Middle East market and prime platform for developing business contacts. Dubai can be considered the hub of economic activity on the Arabian Peninsula and the gateway to the markets of neighboring countries.

In General for the plastic market is to consider that the country of the Gulf Corporation Council (GCC) has become No 1 source of petrochemicals and plastics products in the world. In 2007 ethylene was about 15 million tones including Iran. By the end of 2012, it is more than 30 million tons. The polyethylene production capacities in the GCC are expected to increase from 10.7 million tons in 2009 to 21,5 million tons by the year 2015, according to the latest statistics. The production of polypropylene is also expected to increase from 4.8 million tons in 2009 to 9.5 million tons by 2015, almost double the volume.

The next ArabPlast will be in 2 years in January 2015. We would be pleased to see you there!

**Yours Krah AG**