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The magazine for large **Plastic Pipe Technology** (up to DN/ID 5000mm)

No. **24 / 2020**

ISSN 2626-4366

IMPROFIL

Central Oregon natives to launch Krah USA business

BorSafe™ HE3490-LS - BAHR AL BAQAR
Waste Water Treatment Plant

Sea outfall pipeline
for Egyptian petroleum company

Stiffness of Profile Wall Pipes in Two Worlds -
ASTM and CEN

Content

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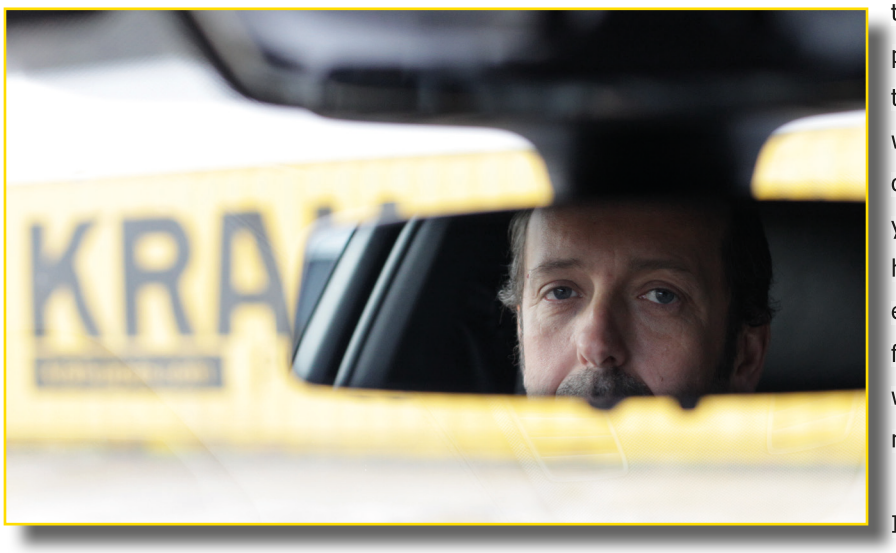
Imprint
Krah Pipes GmbH & Co.KG
Betzdorfer Str. 8
57520 Schutzbach

www.krah.net

Review of a slightly different year

Again, another year is over. And even though it went by as quickly as ever, 2020 was a year that we will all remember forever - but not necessarily in a positive way. Two lockdowns due to Covid 19 and 12 months of restrictions have left their marks worldwide, many have lost family members or friends, countless have lost their businesses. This year has pushed many to their limits and called into question everything we take for granted. But it has also taught us to appreciate the little things and to take more care of ourselves - our family, our health and our surroundings.



Nevertheless, the Krah Group can look back on a lot of positive things this year as well. We have had enough orders to keep our staff busy despite the lockdowns and have even hired new staff to support them. The development of our virtual assembly was a huge step for us, which has contributed a great deal to the fact that we can now go into winter break with a satisfactory financial year. Many companies have buried their heads in the sand and let work rest, but we have used this pandemic to develop further and are now well prepared for the future with our new system. We have set up and commissioned several machines in 2020 without actually being on site. With the help of virtual assistance, we were able to coordinate and successfully carry out the assembly from here. What seemed unthinkable a few months ago, has now convinced us in such a short time that we will continue to use this installation option in the future. At this point, I would like to express my sincere thanks once again to our customers who have accepted this new type of installation and have thus placed their complete trust in us. They have all been rewarded with a good result, which is something to be proud of. Currently, the last machine of 2020 will be installed in the US. When it has been successfully commissioned and the first pipe has been produced, I can end this year satisfied as well and concentrate on the following year. Because we have already planned exciting projects for 2021, which we will tackle with new motivation in January.

I wish you all a peaceful Christmas with your loved ones, even though this time it will be very different from usual. Especially for those who have been hit hard by the pandemic, I wish you a lot of strength and perseverance to get through this and start a better 2021 with new motivation. We should all look forward positively and remember what we have already achieved. Don’t let it get you down!

Merry Christmas,
Alexander Krah

Central Oregon natives to launch Krah USA busine

With help from the Krah Family of Companies

Midge Graybeal is the Chief Executive Officer and Co-Managing Member of Krah USA. Midge has over 30 years of in-depth experience in Project Management, Strategic and Organizational Planning, Events Management, Community/Business Partnership Development, Public Affairs and Marketing Communications, and Public/Private Partnerships. Specializing in Start Ups and Change Management, she has directed strategic and organizational planning for numerous Not-For-Profits, agencies, and business organizations. She works closely with the Executive Staff and Advisory Board, and, as the main link between the different divisions within the company. She will represent the company as required, including attendance of important functions, industry events and public meetings, work closely with the President/CSO (Chief Sales Officer) as well as the CFO (Chief Financial Officer) to prepare annual budgets, complete risk analysis on potential investments, work closely with Human Resources (HR) regarding hiring practices, payroll and benefit disbursement, and assist in establishing goals for each department in partnership with division managers.

Midge Graybeal, CEO Krah USA

Midge Graybeal, Krah USA CEO stated: *„We are extremely priviledged to work with the Krah Group and KAT GmbH to establish Krah USA. The opportunity to develop a proprietary plant in the USA is essential to growth not only for Krah USA for for the Krah Famiy of Companies. We thank you for all the support.*"

Mark Theetge, the President, Chief Sales Officer and Co- Managing Member , will direct the National Sales efforts for Krah USA. With his 30 years of experience in the HDPE market sales. He specialized in product development with specific experience in large diameter HDPE piping products. He is technically proficient with project management skills to bring a project through to successful completion. He started as an HDPE field technician in the late '80s. With this hands-on experience, he developed a full range of technical aspects of fabrication and Fusion Technician. Mark is a trusted leader with proven sales management, pricing, accounting, planning, project execution, negotiations, and team development. Mark previously developed and managed a West Coast Sales Territory, increasing project revenue from $14 million to $21 million. Because of his 30-year industry involvement, Mark has the ground-level experience, depth and breadth, and knowledge regarding the competition. He has leadership experience with developing people in sales management/ product specialist roles, working with both product sales representatives and direct employees. He is experienced in training and educating at all levels in the field, including engineers, district managers, municipality and city managers, farmers, etc. For years, Mark's vision has been to bring the large diameter HDPE Krah pipe technology to the United States, researching and following their footprint internationally for the past 15 years. Mark truly saw the unique and value-added quality in something different and special with this product. Mark is always trying to figure out how to improve things, and this has been his dream in this field, to make products better by bringing something here that is progressive, stronger, more efficient, and truly state of the art.

Mark Theetge, Krah USA President/CSO stated: *„I've been trying to bring the Krah technology to America for 18 years. I'm extremly proud to be able to take this effort to fruition and be part of the Krah family. Alexander Krah, CEO and Owner of the Krah Group and Bulent Kuzkaya, Business Development Director of Krah Advanced Technologies GmbH, have been extremely supportive and helpful through this process.*"

ess on the City of Prineville Railway

After a 3-year analysis and planning process, Krah USA LLC was formed in 2019 by Mark Theetge, President/CSO, and Midge Graybeal, CEO; fully supported through a partnership with KHB GmbH (Krah Germany) and by the Medalist Partners LP.

"Medalist Partners is excited to be partnering with Krah USA LLC. With the implementation of exclusive technology, Krah USA intends to assist in modernizing existing infrastructure relating to agricultural irrigation, municipalities, and other important sectors of the economy through their facility in Prineville," said Greg Richter, CEO of Medalist Partners LP.

Why a plastic pipe manufacturing plant in Central Oregon?

Krah USA is poised to break new ground in social enterprise, conservation and economic development due to the opportunity to be the exclusive manufacturer of Krah process pipe in the Western United States, and the nearly boundless need in Oregon and throughout the West for irrigation modernization and infrastructure upgrades. More than 1,000,000 diversions In the Western United States deliver 80% of surface water to irrigated agriculture. These systems are 100-years-old, lose between 30-70% of water, have extensive water quality issues, and use a significant amount of energy for water delivery. Modernizing these systems is one of the greatest agricultural security and environmental benefit projects in the Western United States. Based on increasing district, private, and government investments into modernization, Krah USA LLC was formed to manufacture high density polyethylene (HDPE) pipe. Senior management of Krah USA have worked with irrigation districts and municipalities for the last 30+ years, and have identified a significant need for a regional piping facility to reduce piping cost, increase supply, and accelerate modernization efforts.

US Government project financing is secured for local irrigation districts and irrigation piping investments that are projected for the next ten years. The need for a regional Krah HDPE pipe manufacturing facility is real:

- Due to tariffs, there has been significant price increases for large diameter steel
- Current piping manufacturers production in the West US is limited and production lines can be booked up limiting supply availiability
- Long-distance shipping adding 25-30% on large diameter pipe to total project price
- There is no large diameter high-pressure HDPE pipe available in the United States

Krah Pipes of Germany has developed technology over the last 40 years to manufacture large-diameter high pressure HDPE pipe. Until recently in the US, it was only available in steel, concrete and sometimes fiberglass. Krah USA is currently working in tandem with the Krah Group, and Krah Advanced Technologies GmbH. They are offering their areas of expertise to ensure that Krah USA has the

Bülent Kuzkaya and President Mark Theetge signing the papers

resources it needs to be successful. The City of Prineville Railway Depot facility has been selected as the headquarters for the pipe manufacturing plant and it is currently under design and construction. Krah USA has leased the largest building (64,000 sf) at the Depot. The plant is scheduled to start production in December. Krah USA will produce several products including the proprietary large-diameter, high pressure Krah HDPE pipe, a variety of sizes of Solid Wall HDPE pipe, manholes, fittings and fixtures.

"We are excited because we get a lease payment, a partner at the Depot. The majority of, if not all of the pellets, used to make the pipe come in from Canada or Texas," states Matt Wiederholt, General Manager of the Railroad Depot. "That is where rail is a crucial part of the inbound product. They need rail, and this building provides right next door."

Krah USA's first expansion of two production lines will most likely occur June of 2021. We anticipate adding a solar array within two years of operation to bring the plant to a „net zero" in energy operations. We have a great partnership with the City of Prineville that ensures the headquarters plant's longevity for years to come.

What was your main motivation to invest in Krah technology in terms of the market in the USA?

Krah USA was established to manufacture high density polyethylene (HDPE) pipe, with a focus on the largest diameter pipe (48"-196") that can handle high pressure applications. This product is not currently available in the United States. It has a vast potential market, including the Western United States irrigation districts facing urgent irrigation system modernization needs, and municipalities that must replace aging water delivery and wastewater treatment infrastructure and other uses.

This plant is in response to two opportunities that have converged, putting Oregon in position to become a field leader at the intersection of agriculture, conservation, social enterprise and rural economic development. The first is an agreement in principle with Krah Pipes to give Krah USA exclusive rights to their advanced German manufacturing technique for large-diameter HDPE pipe, covering several Western states. The second is the opportunity to lease with an option to purchase the City of Prineville Railroad Depot property, which was move-in ready, and install the pipe plant in an existing building in Prineville, Oregon as the manufacturing site, with an adjacent separate office building, and has multiple railroad spurs on the property.

What is Krah USA offering to the market in the USA?

For the first time in the USA, Krah USA will be offering large diameter pipe. Also, shipping charges to the West will be reduced by 80%. One stick of medium size pipe costs $4,000 to $7,000 to ship to the Western United States. We can reduce that cost significantly, and eliminate it for the State of Oregon. Thus, offering significant savings that the client can use to purchase more pipe and complete more projects. Due to lumber mills closing, plants moving out of rural america, and COVID layoffs, we can offer immediate jobs to people who need them. Krah is in process of working with many local hiring venues to offer well-paying, long-term skilled jobs in rural Oregon, and is entertaining resumes for plant managers, production staff, yard workers, administrative and sales professionals.

„This year Krah USA has already met our goal of hiring 14 employees by the end of 2020, with plans to expand to 20 in year two and 30 in year three. The local community, livability of the area, lower cost of living, and recreation opportunities are attractive to recruiting employees.", stated Mark Theetge, President.

A year-long study was conducted on land availability according to the needs of the new plant. After completing due diligence reviewing 10 Central Oregon local sites from Bend to Madras, the City of Prineville Railroad Depot Property was chosen as most compatible to our 22 listed requirements, including an existing and available large scale building, expansion capabilities, loading rail dock and a separate office space among other amenities. The availability of the Railway was extremely important and was a key factor in selecting the facility. Krah USA will be receiving goods and shipping via rail from the Depot. This facility supports the current Administration's efforts and Congress' efforts to bring manufacturing back to the United States and Rural America. Prineville is the perfect venue

for our headquarters pipe manufacturing plant. A plant in Central Oregon is ideally located to efficiently and cost effectively deliver pipe throughout the Western states. As a former lumber mill, the City of Prineville Railroad Depot facility has multiple railroad spurs on the property, offers buildings to expand into, and is within 100 miles of key projects slated over the next few years.

„We could not have better partners than the City of Prineville, with Matt Wiederholt, Railway General Manager and Steve Forrester, City Manager, who both worked tirelessly with Krah for over 9 months to secure the lease space", stated Midge Graybeal, Krah USA CEO.

This was echoed in the message to the Prineville City Council:

"City Council,
Matt and I wanted to provide a quick update on the City of Prineville Railroad. This past Friday, we did receive signatures on a lease with KRAH USA for one of our buildings at the freight depot. We have been working with KRAH USA since summer of 2019. KRAH USA is a pipe manufacturing business that is planning on participating in supplying high density plastic pipe for the irrigation piping projects in Central Oregon, as well as all the Western states. This project is expected to bring jobs to our community and a significant amount of inbound rail freight to our Railroad, with potential for some outbound freight in the future."
-Steve Forrester, Prineville City Manager
-Matt Wiederholt, Railway General Manager

As you know Europe has 30 factories for helical wound pipes and the demand is growing. How do you see this development applicable for the USA?

Krah USA is currently working in tandem with the Krah Group, and Krah Advanced Technologies GmbH, who are offering their areas of expertise to ensure that Krah USA has the resources it needs to be successful. The Krah Family of Companies are bonded through the common goal of producing quality helical wound pipe for their clientele worldwide.

"We are so excited to be a part of the Krah Family of Companies. Every single one has been friendly, open to discussion, helpful and offering resources. We couldn't have been this successful so far without the Krah Team backing us up.", states Midge Graybeal, CEO.

What are the most convenient and important argues to choose Krah pipes and technology?

The Krah pipe is a high-performance plastic pipe production technology. Choosing the Krah technology has many advantages. It has high fexibility, low internal roughness, high abrasion resistance, and high chemical resistance. It is efficient in installation, increasing speed and lowering effort. It provides custom stiffness and custom joining systems. The electrofusion welding process eliminates the need for a massive welding machine that requires manual hand welding inside the pipe. It has no welding seams or any weak points, thus it is leak free. The bright color of the inner surface allows for easier pipeinspection; and, when used for culverts, attracts fish for a friendlier transfer in rivers. For clientele, It reduces piping cost, increases supply, and accelerates modernization efforts. The Krah pipe is virtually industrucable. And, most importantly, it can provide a 100+ year shelf life.

„Krah USA believes the Krah pipe technology should be the only choice for pipe installation due to the numerous benefits and 100 year life span.", states Mark Theege, President.

How will the climate change affect the pipe market in the USA? Speaking of dry soil, flooding etc..

As climate change and drought continue to affect all the States in the US, the need for water conservation becomes increasingly important and essential. The 17 reclamation States in West have thousands of miles of earthen canals that can leak between 20% and 80%. The loss of this water, combined with the dwindling snowpack, decreases the water supply. Thus, increasing the demand to pipe these areas in order to eliminate seepage and evaporation.

"As climate change continues to rise as a focal point, Krah USA views climate change as an opportunity to assist in the conservation of water and provide a

product that does not rust, break, or add to landfills, while providing a long-term solution to infrastructure management and control.", states Midge Graybeal, CEO.

In terms of recycling and environmental protection, what are your goals?

Strategy and Sustainability – Krah USA works to deliver products that improve lives while striving to meet social and environmental goals.

This production plant will be a model for environmental sustainability. Krah USA will be installing a 10-acre renewable solar array to offset energy use and sell power back to Pacific Power, the local utility company, in 2022 with a goal becoming carbon neutral quickly. Water use will be minimal as we will recycle the water used by the machines. HDPE pipe is made from a petroleum by-product, as well as a natural gas by-product (ethylene), turning an energy production waste product into goods that benefit the environment. HDPE Pipe is environmentally friendly and is 100% recyclable. Also, HDPE has a shelf life of 100+ years. Krah USA will support irrigation district's dual mission of creating agricultural resiliency through irrigation modernization and investing in rural agriculture and economies. Other markets include transportation, landfills, oil & gas, municipalities, industrial and on-farm projects across the US.

„Environmental, social and governance (ESG) factors are increasingly being used by investors looking to assess companies' sustainability and risk profile. Krah USA recognizes that an ESG policy is imperitive to our business.. Global demand for energy and stakeholder expectations for a lower-carbon future has never been higher. Our sustainability commitment is strong while we develop our processes", states Mark Theetge, President.

Pillar 1 - Environmental

The environmental pillar measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long term shareholder value.

Pillar 2 - Social

The social pillar measures a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices. It reflects the company's reputation and the health of its license to operate, which are key factors in determining its ability to generate long term shareholder value.

Pillar 3 - Governance

The corporate governance pillar measures a company's systems and processes, which ensure that its board members and executives act in its long term shareholder's best interests. It reflects a company's capacity, through its use of best management practices, to direct and control its rights and responsibilities through the creation of incentives and checks and balances in order to generate long term shareholder value.

Environmental

Krah USA is acutely focused on sustainability and resource use. We are initiating innovative and ongoing actions to advance environmental performance. We are lowering carbon intensity and increasing the use of renewables in our operations while investing in breakthrough technologies. Our plant uses less water, and most of it can be recycled through the manufacturing process. The saw oil that we will be using is water- soluble versus vegetable or motor oil. This ensures when working in stream installations, fish and wildlife will be protected. The pellets we use are a petroleum by-product, as well as a natural gas (ethylene) by-product, which are melted and made into transmission pipe. This High Density Propolyene Pipe (HDPE) is recyclable and reuseable. It can be ground up and made into additional pipe products.

Krah USA's high strength thermoplastic offerings are increasingly viewed across the construction, agriculture, and infrastructure industries as a superior alternative to concrete, steel, and PVC products. They are 3 times faster to install and significantly less expensive on an installed basis than products manufactured using traditional materials. Demand for Krah USA's thermoplastic corrugated pipe, related storm water management and drainage products and septic solutions are being driven by a material conversion trend across many industries. Local and Federal regulators are increasingly seeking more cost effective and environmentally friendly solutions for construction and agriculture applications, which plays directly into the hands of Krah USA's sustainability focused

Krah employee Florian Ermert installing the machine in Prineville

manufacturing process and product portfolio.These efforts have driven significant share gains for corrugated high-density polyethylene (HDPE) and polypropylene (PP) pipe from 10% of the storm sewer market in 2000 to 32% in 2018. Plastic leach field, plastic septic tanks, and manhole covers, have also experienced significant penetration gains from 44% in 2005 to 61% in 2018 and from 15% in 2008 to 24% in 2018, respectively. For example: Preventable irrigation canal losses account for an estimated quarter of food waste, much of it happening between harvest and sale. HDPE pipe allows farmers to pressurize their water delivery systems. Through these irrigation modernization techniques, canals are piped, eliminating water seepage and enhancing safety to the community. Electricity to deliver water is reduced or eliminated, water is conserved through targeted and predicted usage and eliminating evaporation, and fish and wildlife are saved – all while giving water back to the streams and rivers. Flexible pipes can react to changes in their environment, such as seismic events. Flexible pipes still work when other rigid pipe systems already show damages such as breaks or cracks, i.e., as opposed to steel (which rusts) or concrete (which cracks and is supported by rebar which rusts and can only be added to the landfill) - both of which has an anticipated shelf life of 20-50 years. HDPE has a shelf life of over 100 years saving cost of replacing traditional material 2-4 times over. Krah Pipes are made from HD-PE100 (acc. to DIN16961, EN13476, ASTM F894, ISO9969 and other international standards) are produced with an integrated electro fusion joint socket and spigot. The pipe is completely helically extruded with profiles or solid wall, tailor made for any kind of application within the standards. The pipes have no welding seams or any weak points and are completely monolithic made from high density PE100. There is no recycled mixed material used in the Krah pipes, ensuring excellent quality of pipes with a service cycle of minimum 100 years.

Social

Krah USA is committed to bringing manufacturing back to local and rural communities. Our first plant in Prineville, Oregon will replace lost jobs and manufacturing in logging, mills, and rubber materials. Other plants as expansions are secured will mirror being a good steward – of community, land, resources, recycling, workforce development and health and safety. Krah USA is a member of the Oregon Water Resources Congress and Family Farm Alliance, both of which work to preserve water, agriculture and understanding of the challenges facing manufacturers and farmers in the Western US. Krah USA has already reached out to support the local Chamber of Commerce and Central Oregon Economic Development Council. Business Oregon has been integral in supporting this new endeavor. Krah USA supports upward mobility and job training and progression for all employees. We respect diversity and equal opportunities in our workforce. Safety is paramount in our facility and our safety program reflects our consistent monitoring of health and safety compliance on a daily basis for our employees and customer base. Our partnership with the Krah Family of Companies is a testiment of the trust we build with our suppliers, partners, investors and employees.

Governance

Good corporate governance promotes good business. Krah recognizes commitment and effectiveness towards following best practice corporate governance principles with the highest standards of business ethics.

***Authors**:*

Midge Graybeal, Krah USA

Mark Theetge, Krah USA

The new machine during installation, next to the grey pillar you can see one of the virtual assembly cameras

Installing the dismantling station

BorSafe™ HE3490-LS - BAHR AL BAQAR

Waste Water Treatment Plant

Egypt is a fast growing population with expected increase in the population by 40 million people by 2050. As a dry nation; Egypt relies on the Nile and ground water for irrigation but with a limited share of the Nile and very little reusable of ground water, the country is focusing on Waste water treatment Projects to save water and boost productivity of the land.

As Egypt is witnessing the lowest ever register water share per capital in the country in centuries; The Government is moving in a completely different direction to avoid wasting of cubic meters every year through waste water treatment to save water and utilizing modern technologies and improving the irrigation of the farmlands as the irrigation were at risk of contamination due to the untreated agricultural, industrial and municipal wastewater.

The BAHR AL BAQAR waste water treatment plant shall be the largest in Africa and one of the largest in the world; The project capacity is 5 million m3/d. The plant comprises four water treatment lines with a daily processing capacity of 1,250,000 cubic meters each. The treated water will be used to irrigate 140,000 hectares of farmland alongside the Suez Canal. The Project shall improve in the irrigation of the farmlands. KRAH MISR were selected for the production of the spiral wound PE-100 pipes for the project; KRAH MISR established under license from KRAH AG a German machine manufacturer with over 35 years of experience in the design, development and construction of production plants for large diameter pipes and fittings with all different kinds of sizes and stiffness.

KRAH MISR supplied the 2.7km of 1600 mm and 2500 mm spirally wound PE 100 large-diameter pipes for the waste water treatment plant, low pressure application (2.2 bar) and tested accordingly by identifying BorSafe™ HE3490-LS as the best material for the production.

BOROUGE collaborated with KRAH MISR in the production of the pipes while using BorSafe™ HE3490-LS as it will enable the production of the large spiral wound pipes due to its superior properties.

BorSafe™ HE3490-LS is classified as PE100 material which it is an excellent

material for waste water treatment pipelines as demonstrated in multiple regional projects; The benefits of PE100 for such an application are:

• Low installation cost – Because PE100 is flexible and lighter in weight compared to other systems. PE100 is also tougher when compared to other materials, installation time using PE100 is significantly shorter which directly reduces costs.

• Low maintenance cost – Due to the corrosion and chemical resistance during the operational life of the pipeline, maintenance cost will be minimal. Because PE100 can tolerate ground movements better than rigid pipeline, it is less likely to crack during its operational lifetime.

• PE-100 Pipes smooth internal bores facilitating superior flow properties, high operational safety, low tendency to fouling, significantly better abrasion behavior than metal pipe materials, good weldability, and consistently low leakage rates lead to an excellent performance throughout its full life cycle.

• PE-100 Pipes are sustainable Products – from low energy requirements during production of the pipes to the lower carbon footprint through their whole life cycle than other materials; also the possibility of recycling after the whole life cycle make it better for the environment.

After the successful completion of this project, Mr Peter Youssef, General Manager of KRAH MISR remarked, "As the pioneer producer of large spirally wound HDPE pipes in Egypt, KRAH MISR is proud to have successfully delivered one of the largest spirally wound pipes in the country. We are glad to have partnered with Borouge in this aspect."

***Author**: Peter Youssef, Krah MISR*

Stiffness of Profile Wall Pipes in Two Worlds

ASTM and CEN

Introduction

Looking at stiffness classifications of profile wall pipes might be confusing if you are looking with ASTM glasses on CEN standards or vice versa. In the ASTM world, for the pipes the key mechanical characteristic is the ring stiffness constant (RSC). In subclause 4.2, ASTM standard F894 [1] defines six standard RSC classifications: RSC 40, RSC 63, RSC 100, RSC 160, RSC 250 and RSC 400. The unit of RSC is pounds per foot per percent, i.e. [lbf/ft] or in SI units [N/m].

In the standards published by the European Committee for Standardization (CEN), in contrast the key characteristic is the ring stiffness (SN). In Table B.1, EN 13476-1 displays four standard SN classifications: SN 2, SN 4, SN 8 and SN 16. The unit of SN is N/m² or in imperial units psi. The German standard DIN 16961-1 [5] classifies profile wall pipes into the same four groups. Obviously, the numbers (40 to 400 vs. 2 to 16) are significantly different despite of being applied to the same products. Additionally, there are other facts contributing to disorientation:

- SN 2 stands numerically for 2.000 N/m² as SN 16 stands for 16.000 N/m²,
- in ASTM language the ring stiffness expression according to CEN concepts is called pipe stiffness, apparently to set it apart from the term ring stiffness used in the RSC
- pipe stiffness PS and ring stiffness SN have the same units (psi or N/m²), but a simple conversion by units does not lead to the same numbers, since PS and SN are determined numerically with a divergent concept
- despite of RSC and SN being different in numbers and units, both characteristics are derived in tests (ASTM D2412 [2] and EN ISO 9969 [3]) which are in practice nearly the same in terms of set-up as a parallel plate test and measuring load and deflection.

A deeper understanding of the two competing concepts is essential for engineers and manufacturers, who are working with profile wall pipes both in the ASTM and CEN world.

1 Understanding the divergent concepts

RSC and SN are determined in almost the same test regime between parallel plates (Figure 1), i.e. with a load applied on a pipe segment with a defined length for a certain deflection (with some variation: constant length of 6 in. (150 mm) according to D2412; increasing length depending on diameter according to EN ISO 9969). Test speed and deflection range to determine the characteristics are similar.

That is why, the units share the same core. It is the force per unit length to achieve the deflection or reduction of pipe diameter, which is pounds per foot in ASTM and Newton per meter in CEN.

The difference in the concepts is the reference for the load, which is percent of

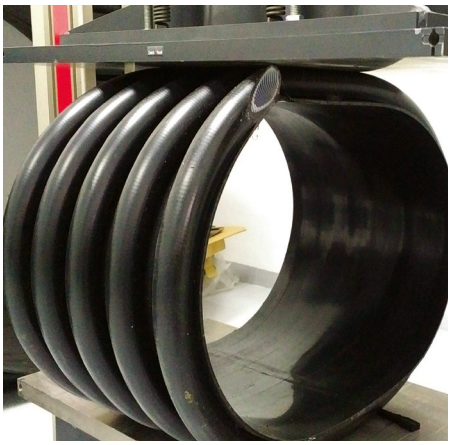


Figure 1: Test setting

pipe deflection, i.e. a relative expression in ASTM and pipe deflection in meter, i.e. an absolute expression in CEN. Thus, the units of RSC or SN can be expressed in the following way.

$$\text{RSC}\left[\frac{\frac{\text{lbf}}{\text{ft}}}{\%}=\frac{\text{lbf}}{\text{ft}}\right]\text{ or }\left[\frac{\frac{\text{N}}{\text{m}}}{\%}=\frac{\text{N}}{\text{m}}\right]$$

$$\text{SN}\quad\left[\frac{\frac{\text{N}}{\text{m}}}{\text{m}}=\frac{\text{N}}{\text{m}^2}\right]\text{ or }\left[\frac{\frac{\text{lbf}}{\text{in.}}}{\text{in.}}=\frac{\text{lbf}}{\text{in.}^2}=\text{psi}\right]$$

Obviously, the ASTM concept is easier to grasp in numbers. RSC 40 simply stands for a load of 40 pounds to cause a deflection of 1 per cent on a pipe segment with a length of 1 foot. The higher the RSC number is, the more load is required to achieve a 1 per cent deflection. The CEN concept is more complex in numbers. SN 2 stands for a load of 2.000 N (2 kN or 200 kg) to cause a deflection of twice 10 mm on a pipe segment with a length of 1

meter. In contrast, the major benefit of the CEN concept is, that in most equations for pipe design the ring stiffness is one part of the term with its theoretical expression.

$$\mathrm{SN} = \frac{EI}{D^3} = \frac{Eh^3}{12D^3}$$

Where:

E = *E-Modulus*

I = *moment of inertia*

D = *diameter*

h = *pipe wall thickness*

This term is part in all relevant technical regulations to calculate structural integrity of pipes, irrespective of whether they are from the ASTM or CEN world. Ring stiffness is used to calculate stresses and deflections of buried pipes and to calculate resistances against buckling under external water pressure.

Another benefit is SN being directly proportional to standard dimension ratio SDR (D/h) of pipes. That is because in the aforementioned equation for SN, wall thickness h in the numerator and diameter D in the denominator have the same exponent. Thus, the fraction can be reduced to SDR.

2 Converting RSC and SN

There is no fixed conversion ratio between RSC and SN. Since 10 mm (0.4 in.) deflection is 1 per cent of a DN 1000 (pipe diameter 40 in.), but only 0.5 per cent of a DN 2000 (pipe diameter 80 in.), at a constant RSC, the SN of a pipe is decreasing with diameter. ASTM F894 gives a conversion table in Annex X1: Relation of RSC to pipe properties and pipe stiffness. This table transforms RSC into PS. The equation of PS is:

$$\mathrm{PS} = \frac{EI}{0{,}149 \cdot r^3}$$

Where:

r = Radius

Therefore, the ratio between PS and SN is fixed, i.e. 53.7. The following Table is Table X1.1 from this appendix, complemented by dimensions and values for SN in SI units.

Nominal Pipe Size		***RSC 40***		***RSC 63***		***RSC 100***		***RSC 160***		***RSC 250***		***RSC 400***	
		Pipe Stiffness	*Ring Stiffness*	*PS*	*SN*	*PS*	*SN*	*PS*	*SN*	*PS*	*SN*	*PS*	*SN*
in.	(mm)	psi	(kN/m²)										
10	(254)	25.0	(3.2)	43.0	(5.5)								
12	(305)	20.8	(2.7)	35.8	(4.6)	51.1	(6.6)						
15	(381)	16.7	(2.1)	28.7	(3.7)	40.9	(5.3)						
18	(457)	13.9	(1.8)	23.9	(3.1)	34.1	(4.4)	54.3	(7.0)				
19.5	(495)	12.8	(1.6)	22.1	(2.8)	31.5	(4.0)	50.1	(6.4)				
21	(533)	11.9	(1.5)	20.5	(2.6)	29.2	(3.7)	46.5	(6.0)				
24	(610)	10.4	(1.3)	17.9	(2.3)	25.6	(3.3)	40.7	(5.2)				
27	(686)	9.3	(1.2)	15.9	(2.0)	22.7	(2.9)	36.2	(4.6)	56.3	(7.2)		
30	(762)	8.3	(1.1)	14.3	(1.8)	20.4	(2.6)	32.6	(4.2)	50.6	(6.5)		
33	(838)	7.6	(1.0)	13.0	(1.7)	18.6	(2.4)	29.6	(3.8)	46.0	(5.9)		
36	(914)	6.9	(0.9)	11.9	(1.5)	17.0	(2.2)	27.1	(3.5)	42.2	(5.4)		
40	(1016)	6.3	(0.8)	10.8	(1.4)	15.3	(2.0)	24.4	(3.1)	38.0	(4.9)		
42	(1067)	6.0	(0.8)	10.2	(1.3)	14.6	(1.9)	23.3	(3.0)	36.2	(4.6)	57.6	(7.4)
48	(1219)	5.2	(0.7)	9.0	(1.2)	12.8	(1.8)	20.4	(2.6)	31.7	(4.1)	50.4	(6.5)

Nominal Pipe Size		**RSC 40**		**RSC 63**		**RSC 100**		**RSC 160**		**RSC 250**		**RSC 400**	
		Pipe Stiffness	*Ring Stiffness*	*PS*	*SN*	*PS*	*SN*	*PS*	*SN*	*PS*	*SN*	*PS*	*SN*
in.	(mm)	psi	(kN/m²)	psi	(kN/m²)	psi	(kN/m²)	psi	(kN/m²)	psi	(kN/m²)	psi	(kN/m²)
54	(1372)	4.6	(0.6)	8.0	(1.0)	11.4	(1.5)	18.1	(2.3)	28.1	(3.6)	44.8	(5.8)
60	(1524)	4.2	(0.5)	7.2	(0.9)	10.2	(1.3)	16.3	(2.1)	25.3	(3.2)	40.3	(5.2)
66	(1676)	3.8	(0.5)	6.5	(0.8)	9.3	(1.2)	14.8	(1.9)	23.0	(3.0)	36.7	(4.7)
72	(1829)	3.5	(0.4)	6.0	(0.8)	8.5	(1.1)	13.6	(1.7)	21.1	(2.7)	33.6	(4.3)
78	(1981)	3.2	(0.4)	5.5	(0.7)	7.9	(1.0)	12.5	(1.6)	19.5	(2.5)	31.0	(4.0)
84	(2134)	3.0	(0.4)	5.1	(0.7)	7.3	(0.9)	11.6	(1.5)	18.1	(2.3)	28.8	(3.7)
90	(2286)			4.8	(0.6)	6.8	(0.9)	10.9	(1.4)	16.9	(2.2)	26.9	(3.5)
96	(2438)			4.5	(0.6)	6.4	(0.8)	10.2	(1.3)	15.8	(2.0)	25.2	(3.2)
102	(2591)			4.2	(0.5)	6.0	(0.8)	9.6	(1.2)	14.9	(1.9)	23.7	(3.0)
108	(2743)			4.0	(0.5)	5.7	(0.7)	9.0	(1.2)	14.1	(1.8)	22.4	(2.9)
114	(2896)			3.8	(0.5)	5.4	(0.7)	8.6	(1.1)	13.3	(1.7)	21.2	(2.7)
120	(3048)			3.6	(0.5)	5.1	(0.7)	8.1	(1.0)	12.7	(1.6)	20.2	(2.6)
126	(3200)			3.4	(0.4)	4.9	(0.6)	7.8	(1.0)	12.1	(1.6)	19.2	(2.5)
132	(3353)			3.3	(0.4)	4.6	(0.6)	7.4	(1.0)	11.5	(1.5)	18.3	(2.3)

Table 1: Modified Table X1.1 of F864

PS is converted to SN ignoring variations caused by test parameters. Comparing the values in the Table, obviously the range of ring stiffness SN in F894 is different from the one in EN 13476-1. For smaller diameters, most profile wall pipes are within the ring stiffness classes SN 2 to SN 8. For greater diameters, there is a significant amount of pipes with a lower ring stiffness than SN 2. Obviously, in the ASTM world a more economic design is possible.

3 References

[1] ASTM F894-19: Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe; 2019.

[2] ASTM D2412-11: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading; 2018.

[3] EN ISO 9969: Thermoplastics pipes – Determination of ring stiffness; 2016-06.

[4] EN 13476-1: Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 1: General requirements and performance characteristics; 2018-10

[5] DIN 16961-1: Rohre und Formstücke aus thermoplastischen Kunststoffen mit profilierter Wandung und glatter Rohrinnenfläche - Teil 1: Klassifizierung und Maße; 2018-08.

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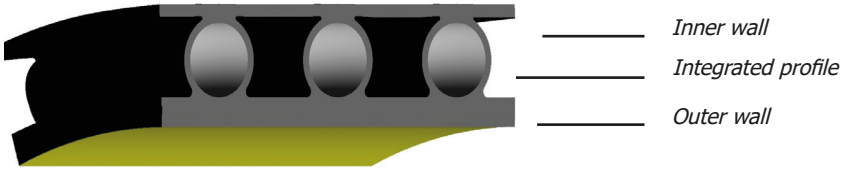
Sea outfall pipeline
for Egyptian petroleum company

Egypt is a big producer and exporter of oil and gas and has an important role in the worldwide oil- and gas industry. It is the country, which connect North-East-Africa with Asia and has also a high political and economically position in the region. Egypt has one of the longest histories of any country, tracing its heritage along the Nile Delta back to the 6th–4th millennia BCE. The ancient Egypt is considered as the cradle of civilisation.

Nowadays the oil and gas industry are very important for the Egyptian economy and secures the energy supply of the strong growing population in Egypt. Egypt has around 100 Million inhabitants and owns 1 Million square Kilometres. The El Nasr Petroleum company (N.P.C) belongs to the local oil- and gas industry and is located in the port of Suez. The El Nasr Petroleum company was already founded on 1911 by the British company Abar Solutions Petroleum. The actual production of N.P.C reaches 6.5 million tons per year.To improve the environmental sustainability the N.P.C. has planned the construction and installation of two outfall pipelines to dispose the treated industrial water into deep sea. Last year also the environmental minister issued a law to regulate the discharge of treated water into the sea. A big environmental progress, because for many years the treated water was discharged on the shore-line, which cause pollution and destroying the marine life.
The considered minimum discharge flow is 3000 m3/hr and the maximum discharge flow is 9000 m3/hr. As result of the hydraulically calculation both pipelines are designed with an internal diameter of 1500 mm. For the maximum pressure load capacity 2,5 bar was defined. After presentation of different solutions and pipe materials to N.P.C. the Krah pipe concept was selected as most cost-effective and durable solution and because of the technical properties, meeting the requirement for the project.

All pipes are produced in Egypt at KRAH MISR by using high quality Polyethylene PE100 rawmaterial "Borouge HE3490 LS". The raw material has a Minimum Required Strength (MRS) of 10 MPa and provide a high resistance against external loads. For the pipes a profiled wall structure



with adequate inner wall to handle the inner pressure was designed.Following the standard DIN 16961 and considering PE100 and Design Coefficient of 1,25 (acc. ISO 12162) the pressure class PN 2,5 is correlating with SDR 65, what means 24 mm solid wall at diameter DN/ID 1500 mm.

The additional profiled wall structure ensures highest grade of pipe stiffness and buckling resistance. The pipes fulfills a higher stiffness than SN 16 [kN/m²] (calculated with flexural modulus of 1000 MPa.

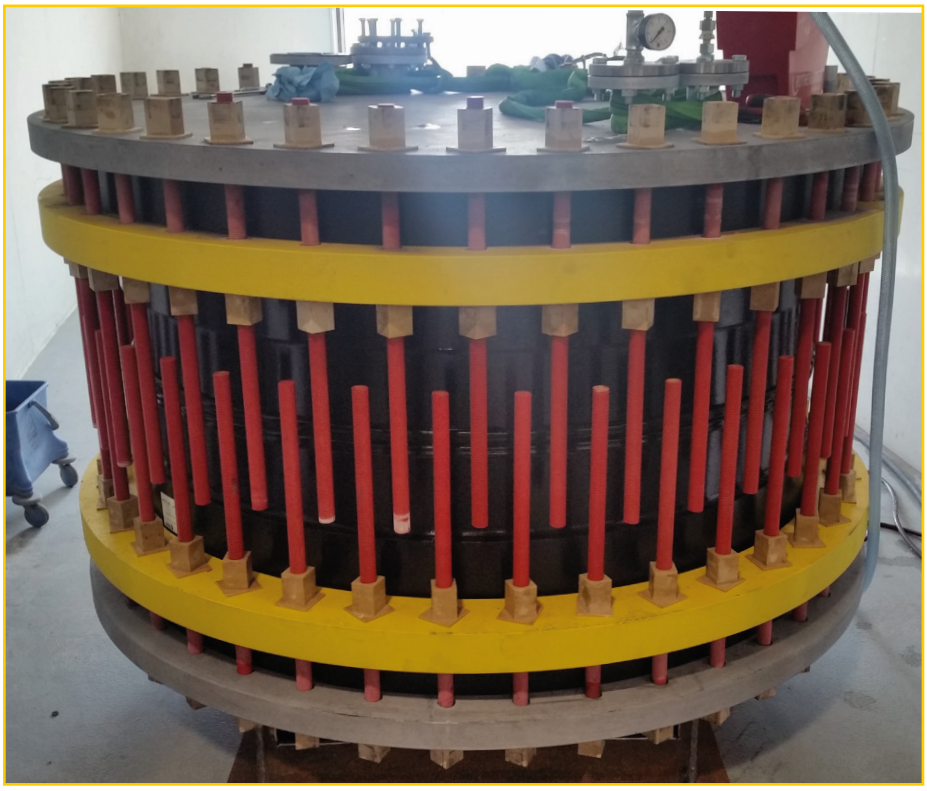
All pipes are produced with integrated spigot and electrofusion-socket. For homogenous jointing of outer wall an additional Krah Electrofusion coupler is manufactured. Due to this technology the axial pulling load during installation could distributed to total axial wall thickness of inner and outer wall. Further the bending resistance could be increased, what was an advantage for the selected installation procedure. Because of the site conditions, especially the native very soft soil, the planner preferred an installation of the pipe string on piles.

The pipes are fixed in special clamps every 6 m and weighted by concrete ballast to ensure the necessary uplift safety. The deflection between the piles has to be minimized, what is ensured by using the double wall profile and double wall jointing of the pipes. Regarding pipe design and detailed calculation of load capacity of the pipe system during handling, installation and operation KRAH MISR cooperated with the German engineering and consulting companies Selle Consult GmbH and Plaspitec GmbH. This kind of third party support was helpful for all stages of the project, especially because of changing conditions for installation-process during the project proceeding.

Project stages:

So, all different szenarios for installation could be verified and confirmed in time.

The pipes are produced in 6 m length and jointed to 12 m length in the Krah factory before delivery. Each pipe and joint are inspected by QC department and each joint is additionally leak-tested with special joint-testing-device before shipment the 12 m length. The weight of the shipped 12 m length is around 3 tons and for transport small trucks could be used. The low weight simplified also the handling at site, where firstly the pipes are jointed to 100 m strings with flange joint at the ends. The pipes strings are pressure tested with 1,5 times the maximum design pressure (1,5 x 2,5 = 3,75 bar). Instead of using flat gaskets or simple O-rings, special rubber sealings were developed to maintain the pressure and simplify assembling in marine environment. The used stub-ends are produced out of solid wall Krah pipes and machined on a turning machine to get the final shape and sealing-surfaces. The design corresponds to the GRE Krah Pipe flanges and the GRE Krah Pipe screws. The GRE flanges, screws and nuts, produced in Germany, are chemical resistant against marine water and well-proven for this application. Long term tests under marine water environment



Krah pipe flange connection during pressure test

document the distinguish properties. The usage of GRE flanges avoids the installation of complex cost-intensive cathodic protection or usage of super duplex steel. That reduces costs and the effort for maintenance significantly.

Because of local situation at site the pipe strings could be prefabricated not directly at the place for launching, but has to be lifted on wheel-carrier and transported to the shore. String by string the pipes are transported and lifted and pushed into the sea. Because of this special launching process an additional artificial ramp and special railway could be avoided. The final installation and sinking process is done after the pipe strings are pulled to destined position.

The maximum installation depth is around 6 m Because the range between the water level at rising and falling tides is more than 2 m, the installation is conscious planned to start during lowest tide level. The controlled sinking process by using 3 ton concrete ballast blocks and controlled water filling let the sink into the projected position. Hydrostatic test is made for complete pipeline (500 meter each) to guarantee leakage free pipelines. The pipes are connected on shore with the outfall chamber by using Krah pipes wall penetration fittings. Due to the special design of the wall penetration, the pipe gets radial and axial anchored in the concrete wall. The tailormade design ensures leak-tightness penetration of the chamber wall.

Pipe on wheel carrier

Lifting and pushing into the sea

Easy handling off-shore

Wall penetration

Outfall chamber

During installation

The integrated EPDM puddle flange and the additional installed swelling material guarantees perfect sealing and maximum safety. The integrated flange joint allows total closure in case of maintenance and also pressure tests of the string after installation.

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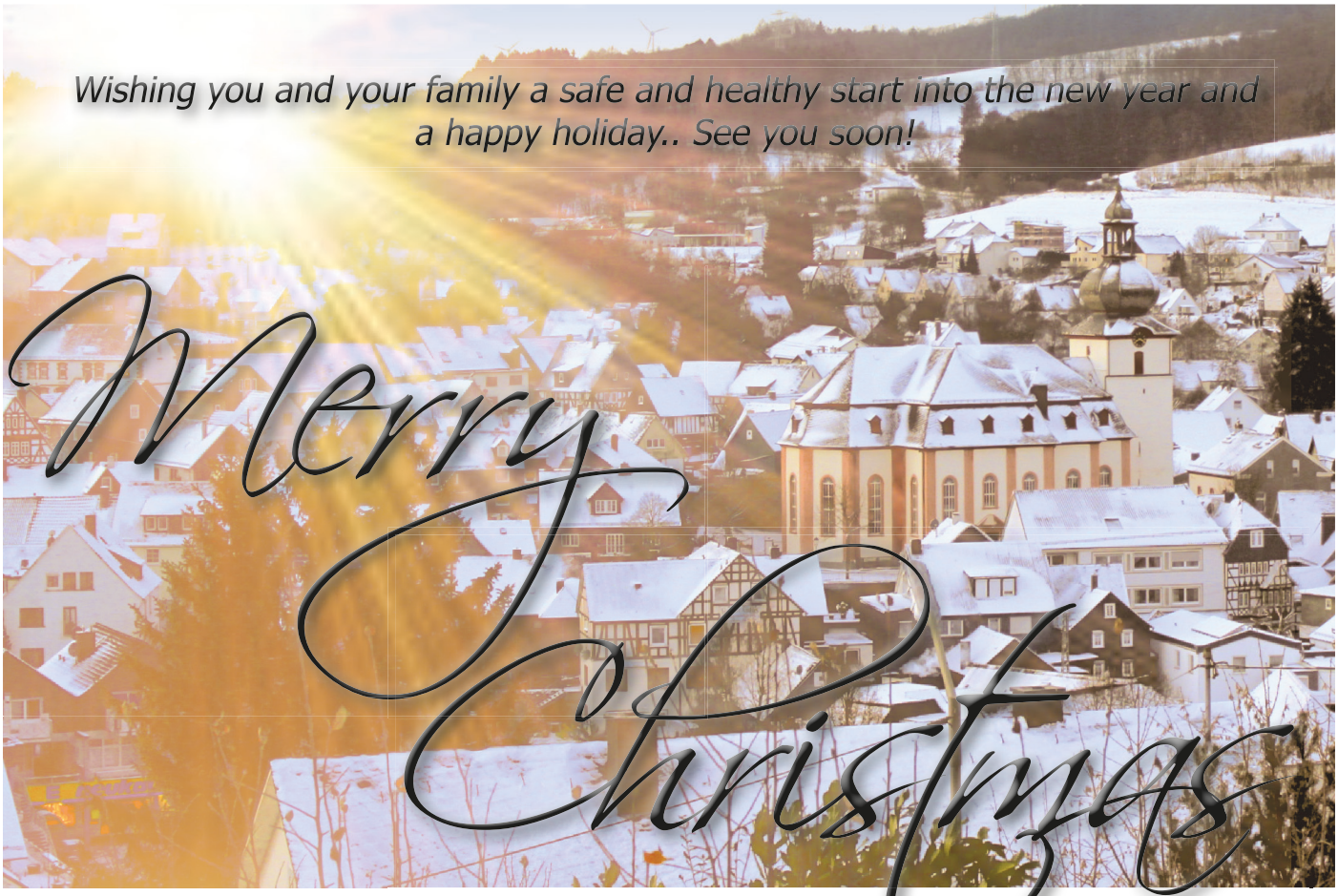
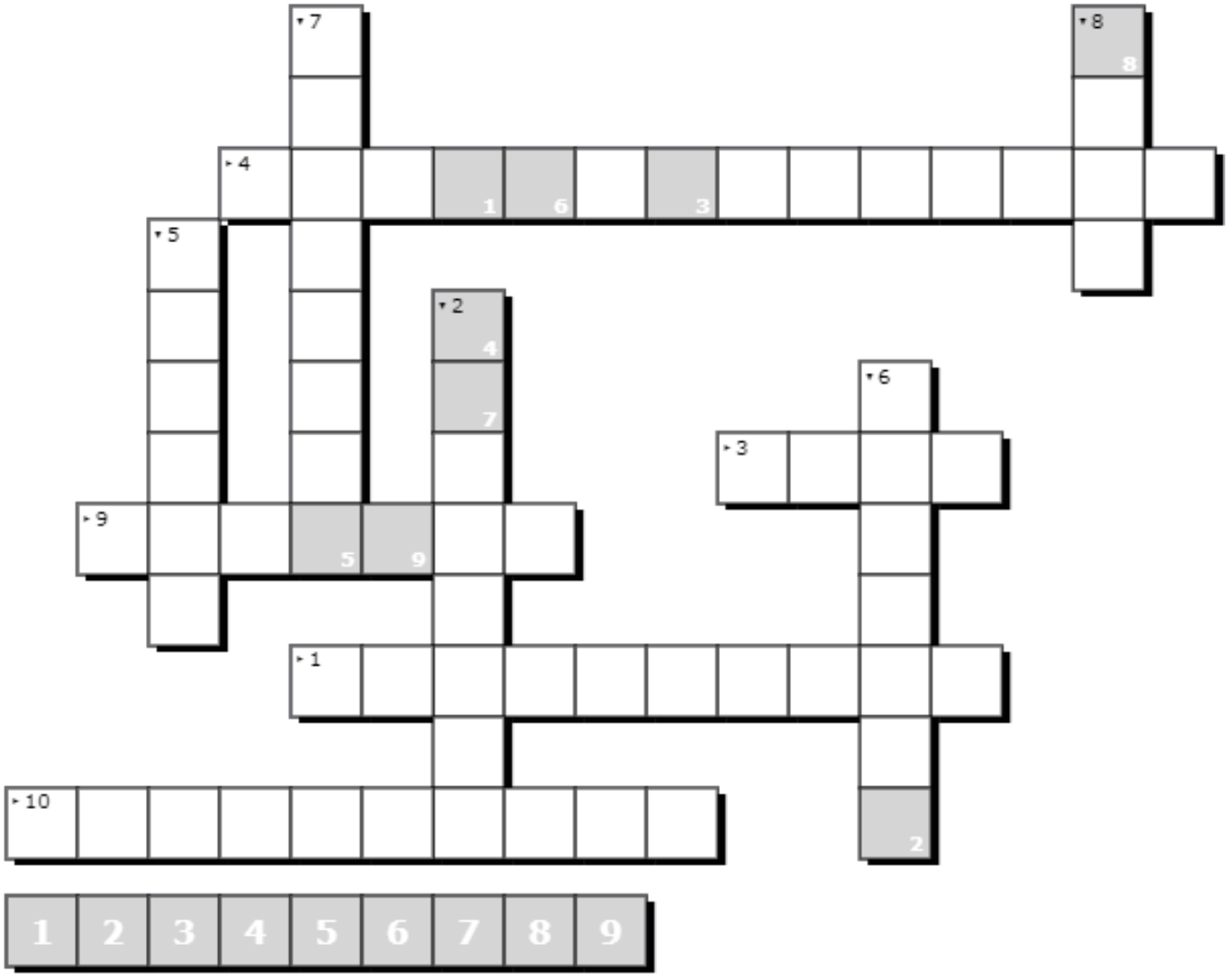


Krah Christmas crossword

Send us the solution word to marketing@krah.net!



1. Where is the new US production plant located?
2. For centuries there have been 2 competing measurement systems used all over the globe - which one is used in the US?
3. Which basic colour does a Krah machine have?
4. To measure the quality of compaction, the ..... is measured.
5. Which material is responsible for the black outside colour of Krah pipes and the UV resistance?
6. What's the famous reindeer called which even has its own song?
7. For 10 years there has been a Krah pipe factory in Egypt. What else is egypt famous for?
8. What's the abbreviation of the US standardization organisation?
9. What's the name of the Krah Misr CEO? (Last name)
10. What is the country with a Krah factory that will celebtrate the beginning of 2021 first?

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