DUCTILE IRON PIPE SYSTEMS

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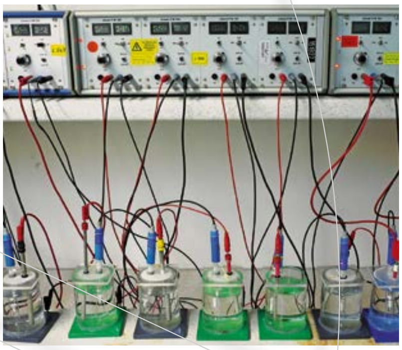


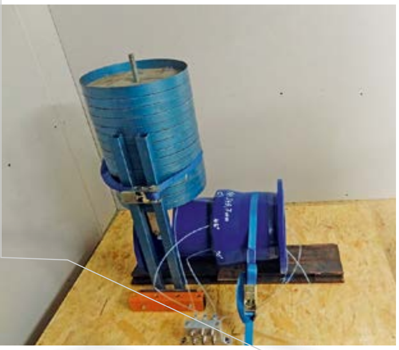
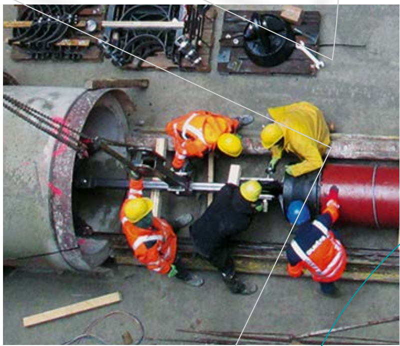

Sustainably superior – ductile iron pipe systems

Liebe Leserinnen und Leser,

die Veränderung, die der Klimawandel mit sich bringt, kann viele Gesichter haben. Einige stehen in den letzten Jahren immer stärker im Focus der öffentlichen Wahrnehmung. Sommerliche Starkregenereignisse und lang andauernde Hitzeperioden, mit ihren teilweise fatalen Folgen für das Leben in den Städten und Gemeinden, führen uns die Verwundbarkeit (Vulnerabilität) unserer urbanen Infrastrukturen vor Augen. Schneemangel in den Mittelgebirgen und in den Alpen zeigen uns auf, wie stark der winterliche Tourismus und somit die wirtschaftliche Grundlage ganzer Regionen vom Klimawandel beeinflusst werden kann. Auch vor diesen Hintergründen hat bereits im Oktober 2014 der Europäische Rat einen Rahmen für die Klima- und Energiepolitik bis 2030 beschlossen, um das langfristige Ziel einer Senkung der Treibhausgas-Emissionen der EU um 80 % bis 95 % bis 2050 in möglichst kostenwirksamer Weise zu erfüllen.

Vielleicht fragen Sie sich an dieser Stelle: Was haben der Klimawandel, die Minderung der Treibhausgas-Emissionen und Vulnerabilitäten urbaner Infrastrukturen mit duktilen Guss-Rohrsystemen zu tun? Einige Antworten auf diese Frage finden Sie im EADIPS®/FGR®-Jahresheft 51.

So wird bereits seit Jahren der Anteil an regenerativen Energieträgern in Form von Wasserkraftwerken in den Alpenregionen permanent ausgebaut. Hier tragen robuste und betriebssichere Kraftwerksleitungen aus Rohren, Formstücken und Armaturen mit formschlüssigen Steckmuffen-Verbindungen aus duktilem Gusseisen in Kleinwasserkraftwerken dazu bei, die Treibhausgas-Emissionen zu verringern. Aber auch die Steigerung der Energieeffizienz in Wasserversorgungsnetzen durch den Einsatz von strömungsoptimierten Armaturen ist ein wichtiger Baustein bei der Verringerung der Treibhausgas-Emissionen.

Ein weiteres Einsatzgebiet duktiler Guss-Rohrsysteme sind die Leitungssysteme von Beschneiungsanlagen, die den winterlichen Tourismus auch in schneearmen Zeiten planbar machen. Damit die Vulnerabilitäten urbaner Infrastrukturen verringert werden können, bieten z. B. duktile Guss-Rohrsysteme mit ihren robusten und wurzelfesten Steckmuffen-Verbindungen die Möglichkeit, Speicherräume in Leitungsgräben zu schaffen. Die Funktion der Speicherräume in Leitungsgräben wird unter dem Begriff „Schwammstadtprinzip" erläutert.

Lassen Sie sich inspirieren.

Es grüßt Sie herzlich
Ihr

Christoph Bennerscheidt

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European Association for Ductile Iron Pipe Systems
Fachgemeinschaft Guss-Rohrsysteme

Sustainably superior –
ductile iron pipe systems

Dear readers,

The change that climate change entails can have many faces. In the last few years, some have become more and more the focus of public perception. Summerly heavy rain events and long-lasting heat periods, with their partial fatal consequences for the life in the cities and communities, lead us to the vulnerability of our urban infrastructures. Lack of snow in the low mountain ranges and in the Alps shows how strongly the winter tourism and thus the economic basis of entire regions can be influenced by climate change. Against this background, in October 2014, the European Council adopted a framework for climate and energy policy by 2030 to meet the long-term goal of reducing greenhouse gas emissions by 80 % to 95 % by 2050 in the most cost-effective way possible.

Perhaps you are asking yourself: What do climate change, the reduction of greenhouse gas emissions and the vulnerability of urban infrastructure have to do with ductile cast iron pipe systems? You can find some answers to this question in this issue of the EADIPS®/FGR® annual journal."

For example, the share of renewable energy sources in the form of hydroelectric power stations in the Alpine regions has been steadily expanded for years. Robust and reliable power lines made of pipes, fittings and valves with restrained socket joints made of ductile cast iron in small-scale hydropower plants have been helping to reduce greenhouse gas emissions for years. But also the increase of energy efficiency in water supply networks through the use of flow-optimized valves is an important module in the reduction of greenhouse gas emissions.

Another area of application of ductile cast iron pipe systems are the piping systems of snowmaking plants, which make winter tourism possible even during times with a lack of snow. In order to reduce the vulnerability of urban infrastructures, ductile cast-iron pipe systems with their robust and root-proof push-in joints offer the possibility of creating reservoirs in trenches. The function of reservoirs in trenches is explained under the term "sponge city principle".

Sincerely

Yours

Christoph Bennerscheidt

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European Association for
Ductile Iron Pipe Systems
Fachgemeinschaft Guss-Rohrsysteme

In unseren Breiten macht sich der Klimawandel mit sommerlichen Überhitzungen und Starkregenereignissen zunehmend bemerkbar, zum Teil mit Katastrophen-Charakter. Wenn es gelänge, den unterirdischen Porenraum der Bettung von Abwasserkanälen als vorübergehenden Speicherraum für Regenfluten zu nutzen und dieses Wasser auch noch den Stadtbäumen zur Verdunstung verfügbar zu machen, dann würden gleich zwei Fliegen mit einer Klappe geschlagen. Voraussetzung für diese Abwasserkanäle sind mechanisch äußerst robuste Rohre, die eine Bettung aus scharfkantigem Grobmaterial von 100 mm Korngröße verkraften und eine wurzelfeste Verbindung besitzen. Duktile Gussrohre mit Zementmörtel-Umhüllung (ZM-U) sind der Schlüssel zu dieser Lösung.

In our latitudes, climate change is having an increasing impact with summer overheating and heavy rain events, sometimes with a catastrophic character. If the underground pore space of the bedding of sewers could be used as a transitional storage space for floods of rain and if this water could also be made available to city trees and hence evaporated, then this would be killing two birds with one stone. One precondition for these sewage systems is having pipes which are extremely mechanically robust, which can cope with a bedding consisting of sharp-edged coarse material with a grain size of 100 mm and which are root-proof. Ductile iron pipes with cement mortar coating are the key to this solution.

Wenn in den bereits intensiv genutzten Tiefen unter unseren Metropolen weitere Infrastrukturen gebaut werden müssen, dann werden diese Projekte immer aufwändiger, komplexer und mutieren zu wirtschaftlich-technischen Schwergewichten. Der Anteil der Materialkosten am Gesamtprojekt wird dabei zunehmend geringer, während die Anforderungen an die Betriebssicherheit über extrem lange Nutzungsdauern steigen. Duktile Gussrohre sind erste Wahl, wenn es darum geht, eine komplizierte Abwasserüberleitung im Grundwasser unter immensen Zwängen der benachbarten Strukturen zu bauen. Spannende Lektüre, selbst noch für „alte Hasen"!

When even more infrastructures have to be installed in the already intensively occupied depths beneath our large cities, then these projects become ever more expensive and complex and mutate into economic and technical heavyweights. The proportion of material costs to the project as a whole becomes increasingly lower, while the requirements for operational reliability over extremely long working lives increase. Ductile iron pipes are the first choice when it comes to building a complicated wastewater transport system in groundwater under immense constraints from adjacent structures. Exciting reading, even for old hands!

Interaktion von Baumwurzeln mit der Leitungsinfrastruktur ist seit Jahrzehnten Diskussionsstoff zwischen den Leitungsbetreibern und den Grünflächenämtern. Ein Spezialfall ist der Wurzeleinwuchs in Rohrverbindungen, der im schlimmsten Fall mit einer verstopften oder

For decades now, the interaction between tree roots and piping infrastructure has been a matter for discussion between pipeline operators and those in charge of parks and gardens. A special case is the penetration of roots into pipe joints which, in the worst cases, ends up undichten Leitung endet. War früher der Hydrotropismus das gängige Ursache-Wirkungsmodell, bei dem die Wurzel dem Wasser entgegenwächst, also eine bereits geringfügige Leckage benötigt, so ist nach den Forschungsergebnissen der letzten 15 Jahre die Verfügbarkeit von Sauerstoff bei zu geringem Anpressdruck des Dichtelements die wirkliche Ursache für den Wurzeleinwuchs. Daraus erwachsen konkrete Anforderungen an Steckmuffen-Verbindungen von Kanal- und Wasserrohren, die zunehmend in den Produktnormen ihren Niederschlag finden.

Fusion Bonded Epoxy Resicoat R4® schützt erdüberdeckte Gusskomponenten seit über 25 Jahren vor Korrosion

Torsten Leitermann 33

Die Entwicklung der Epoxidharz-Pulver-Beschichtung von Formstücken und Armaturen aus duktilem Gusseisen ist eine Erfolgsgeschichte, vor allem deswegen, weil von Anfang an konsequent auf Einhaltung höchster Anforderungen geachtet wurde. Der Beitrag fasst den neuesten Stand der Technik zusammen. Er reicht von der Polymerisationschemie des Epoxidharzes, Pulverherstellung und -verarbeitung über den Nachweis der Korrosionsschutzwirkung durch mehrere Messmethoden bis zur Darstellung der trinkwasserhygienischen Eignung mit Blick auf nationale und europäische Regularien. Wer mehr als einen oberflächlichen Eindruck von dieser Technologie bekommen möchte, der findet hier Antwort auf die wichtigsten Fragen.

Landeshauptstadt von Sachsen-Anhalt setzt auf Armaturen und Formstücke aus duktilem Gusseisen mit Epoxidharz-Pulver-Beschichtung

Sigmund Pionty und René Pehlke 38

Eine Großstadt mit hohen Verkehrslasten, gleichzeitigem Ausbau der Straßenbahntrassen: hier werden höchste Anforderungen an die Langlebigkeit der Leitungsinfrastruktur gestellt. Armaturen und Formstücke aus modernen Gusswerkstoffen mit integralem Korrosionsschutz geben dem Betreiber die Gewähr für eine lange Nutzungsdauer bei geringstem Instandhaltungsbudget.

Die neue Generation weichdichtender Schieber

Matthias Müller 41

Nichts ist so gut, als dass es nicht noch weiter verbessert werden kann. Diese bekannte Aussage behält ihren Wahrheitsgehalt umso

with a blocked or leaking pipeline. While it was previously thought that hydrotropism was the common cause, where the root tends to grow towards water, this meant that there already had to be some slight leakage. But research results over the last 15 years have shown that the availability of oxygen due to insufficient contact pressure of the sealing element is the true cause of root penetration. This has led to specific requirements for push-in joints for sewage and water pipes, which are increasingly being reflected in product standards.

Fusion Bonded Epoxy Resicoat R4® has been protecting buried cast iron components against corrosion for more than 25 years

Torsten Leitermann 33

The development of the epoxy resin powder coating of ductile cast iron fittings and valves is a success story, particularly because, from the start, consistent attention has been paid to meeting the highest demands. This contribution gives a summary of state-of-the-art technology. It covers the polymerisation chemistry of epoxy resin, the production and processing of powders, proving the corrosion protection effect by numerous test methods, as well as a description of its suitability in terms of drinking water hygiene, with a glance at national and European regulations. Anyone who wants to have more than a superficial idea of this technology will find an answer to the most important questions here.

The state capital of Saxony-Anhalt puts its trust in valves and fittings in ductile cast iron with epoxy powder coating

Sigmund Pionty and René Pehlke 38

A large city with heavy traffic loads and the simultaneous extension of its tramline system: here the highest requirements are set for the longevity of the pipeline infrastructure. Valves and fittings in modern cast iron materials with integral corrosion protection give the operator a guarantee of a long working life, with the lowest maintenance budget.

The new generation of resilient seated gate valves

Matthias Müller 41

Nothing is so good so that it cannot be improved upon a little more. This well-known saying becomes even truer when there is close cooperamehr, je enger die Zusammenarbeit zwischen Hersteller und Anwender eines Produkts ist. Die Entwicklung neuer Fertigungstechnologien und neuer Werkstoffe wird vom Hersteller genau beobachtet, vom Anwender kommen Wünsche und Beobachtungen aus dem täglichen Betrieb. In der Entwicklungsabteilung des Herstellers laufen diese Informationen zusammen und ergeben so einen stetigen Fluss von Innovationen. Der neue Keilschieber INFINITY ist ein sprechendes Beispiel!

Trinkwassertransport mit höchsten hygienischen Anforderungen, wie sie erst in der Zukunft zu erwarten sind, mit Rohrleitungsmaterial, welches durch stark aggressives Bettungsmaterial beansprucht wird, das ist das Spielfeld für emaillierte Formstücke und Armaturen. Dazu ein Betreiber, der sich bei seinen Lieferanten aktiv in die Optimierung seiner Komponenten einbringt, das alles ist die Voraussetzung für das hohe Qualitätsniveau unseres Trinkwassers. Innen und außen emaillierte Armaturen bieten Gewähr für extrem lange Nutzungsdauer bei trinkwasserhygienischer Höchstleistung.

Nichts ist so gut, dass es im Detail nicht noch weiter verbessert werden kann! Diese Feststellung der Authorin zeigt direkt die Gründe dafür auf, warum viele unserer mittelständischen Unternehmen in der Welt als „hidden champions“ angesehen werden. Ihre enge Verbindung mit der Gedankenwelt ihrer Kunden erzeugt Innovation zum Nutzen des Kunden sowie anerkannte Marktführerschaft. Bei den Armaturen existiert ein stetiger Strom von Verbesserungen, Optimierungen, sei es am Werkstoff, an der Beschichtung, an der Konstruktion. Anders ist der Unternehmenserfolg im globalen Wettbewerb nicht zu bekommen.

Von der geplanten europäischen Vereinheitlichung nationaler Regelungen im Bereich der Gesundheit und des Verbraucherschutzes sind auch Elastomer-Dichtungen im Kontakt mit Trinkwasser betroffen. Galten früher Anforde-

tion between the manufacturer and the user of a product. The development of new production technologies and new materials is something which is closely monitored by the manufacturer, while the user comes up with desires and comments from his day-to-day operation. This information is brought together in the manufacturer's development department and so a constant flow of innovations results. The new INFINITY gate valve is an eloquent example of this!

The transport of drinking water to the highest hygienic requirements, only to be expected in the future, using piping material which is exposed to very aggressive bedding material – this is where enamelled fittings and valves come into their own. The active involvement of an operator with his suppliers in optimising components is an essential condition for the high level of quality of our drinking water. Valves which are enamelled inside and outside offer a guarantee of an extremely long working life, with maximum performance in terms of drinking water hygiene.

Nothing is so good that it cannot be improved in the small details! This conclusion by the author is directed precisely at the reasons why many of our medium-sized companies across the world are seen as "hidden champions". Their close connection with the perceptions of their clients, produces innovation for the benefit of the client as well as renowned market leadership. In the world of valves there is a constant flow of optimisations, whether in the material, in the coating, or in construction. Nothing less will do if a company is to succeed in global competition.

The intended European unification of national regulations with respect to public health and consumer protection touches also elastomeric seals in contact with potable water. The former existing requirements for migration of certain rungen an den Übergang bestimmter Stoffe aus dem Elastomer an das Trinkwasser, so sind heute Positivlisten in Gebrauch, in denen die zur Produktion von Dichtungen toxikologisch bewerteten und zugelassenen Stoffe aufgeführt sind. Dies schränkt den Hersteller von Dichtungen bei der Rezeptur ein, weil eine Dichtung zusätzlich mechanische-technologische Anforderungen erfüllen muss, damit die gewünschte Langzeitfunktion (Dichtheit) eingehalten wird. Auch hier ist wieder ein ständiger Evolutionsvorgang zu beobachten.

Löschwasserleitungssysteme in Bauwerken haben ein merkwürdiges Anforderungsprofil: Sie sollen so selten wie möglich zum Einsatz kommen, müssen aber während der gesamten Nutzungsphase des Bauwerks stets zuverlässig funktionieren. Bei Löschwassersystemen in Verkehrstunneln kommen weitere Anforderungen hinzu: Nichtbrennbarkeit der Komponenten, dauerhafter Schutz der Innen- und Außenflächen, leichte Montierbarkeit unter beengten Platzverhältnissen und einiges mehr. Löschwassersysteme aus duktilem Gusseisen in Verkehrstunneln haben eine lange Tradition, weil sie die Gesamtheit aller Anforderungen in idealer Weise erfüllen, so auch dieses Mal beim Neubau eines Schweizer Autobahntunnels, wo bekanntermaßen die höchsten Sicherheitsanforderungen herrschen.

Skitourismus als essentieller Wirtschaftsfaktor, vom Klimawandel verursachte kürzere und mildere Winter, das sind die Voraussetzungen für den steigenden Bedarf von Hochdruckleitungen in den Skigebieten. Duktile Guss-Rohrsysteme mit ihren einfach und sicher montierbaren Steckmuffen-Verbindungen, mit ihrer extremen Druckbelastbarkeit, mit ihrem kompletten Formstück- und Armaturenprogramm sehen sich bei den Planern und Betreibern von Beschneiungsanlagen in einer Favoritenrolle.

substances from the elastomer to the potable water are replaced by positive lists which contain toxicologically assessed and permitted materials to produce sealing gaskets. The possibilities of the gasket manufacturer are hereby constricted because the seal has also to comply with additional mechanical and technological requirements to achieve the intended long term function (leak tightness). It is again here where we can observe a steady evolution.

Extinguishing water piping systems in all types of constructions have a curious job specification: they should need to be called on as little as possible but they must always operate reliably throughout the entire working life of the construction. When it comes to extinguishing water systems in transport tunnels, there are further requirements to be met: non-combustibility of components, permanent protection of interior and exterior surfaces, ease of assembly in tight space conditions and several more. Ductile cast iron extinguishing water systems in transport tunnels have a long tradition because they meet the whole set of requirements in an ideal way, as can be seen in this case with the construction of a new motorway tunnel in Switzerland where, as we know, the highest safety requirements prevail.

With ski tourism as an essential economic factor and with the shorter, milder winters caused by climate change, the requirement for high-pressure pipelines is increasing in skiing resorts. Ductile iron pipe systems with their secure, easily assembled push-in joints, their extremely high pressure loading capacity and their full range of fittings and valves rank as favourites among planners and operators of snow-making equipment.

Im alpinen Gelände schlummern trotz ausgiebig genutzter Wasserkraftressourcen immer noch beträchtliche Potenziale. Der Beitrag schildert Projektierung und Bau eines Kleinwasserkraftwerks mit einer geodätischen Höhendifferenz von fast 1.000 m im Tessin. Es lassen sich zunehmend Anstrengungen beobachten, die zu einer möglichst unauffälligen Eingliederung der Infrastrukturen in den natürlichen Gebirgsraum führen. Triebwasserleitungen aus duktilen Guss-Rohrsystemen werden dabei in Bruchsteinmauern verborgen.

Not macht erfinderisch! Beim Bau von Kleinwasserkraftwerken im alpinen Gelände tauchen oft unvermutet Probleme auf, die der Planer lösen muss. Mit Hilfe duktiler Gussrohre und Formstücke lassen sich in Zusammenarbeit mit einem kompetenten Team oft die Schwierigkeiten überwinden. Die einzig mögliche Trasse einer geplanten Turbinenleitung verläuft in einem Rutschhang. Speziell entwickelte Kompensator-Formstücke mit je 80 cm zulässiger Dehnung entschärfen das Problem.

Seit Langem bewährt und immer wieder beschrieben, sind duktile Guss-Rohrsysteme beim Bau von Kraftwerksleitungen einfach nicht zu schlagen! Das schwierige und unzugängliche Gelände mit seinen felsigen Böden, die hohen technischen und sicherheitsrelevanten Randbedingungen, zusätzliche Forderungen der Umweltbehörden, dies und noch mehr lassen jede Kraftwerksleitung zu einer individuellen Aufgabe werden. Wenn dann noch Passrohre nach Aufmaß und ohne Bauverzögerung, mit speziellen Anforderungen an die Längskraftschlüssigkeit und den Korrosionsschutz an den Einbauort geliefert werden müssen, dann ist der Erfahrungsschatz aller am Bau beteiligten unabdingbar. Der Bau der Triebwasserleitung für das Kraftwerk Bristen ist ein gelungenes Beispiel dafür.

In alpine terrain, considerable potential remains slumbering despite the extensive use of hydropower resources. The article describes the design and construction of a small hydropower plant with a geodetic elevation difference of almost 1.000 m in the Ticino. Increasing efforts are being made to ensure that the infrastructures are integrated into the natural mountain area as inconspicuously as possible. Penstock pipelines made of ductile iron pipe systems are hidden in broken stone walls.

It is true that necessity is the mother of invention! When constructing small hydropower plants in Alpine areas, unexpected problems often arise which have to be solved by the planners. With the help of ductile iron pipes and fittings and with the backup of a competent team of workers, such difficulties can be overcome in many cases. The only possible route for a planned turbine pipeline is down a slope where the soil is unstable. Specially developed expansion fittings, each with a permissible extension of 80 cm, take the edge off the problem.

Proven over the years and described again and again, ductile iron pipe systems simply cannot be beaten for the construction of power plant pipelines! Difficult, inaccessible terrain with its rocky ground, demanding conditions in terms of technology and safety standards, additional requirements set by the environmental agencies, all these things and more mean that every power plant pipeline is its own individual task. Add the fact that made-to-measure adapter pipes with special requirements for restrained locking and corrosion protection need to be delivered to the site without delaying construction progress, then the pool of experience of all involved in the project becomes indispensable. The construction of the penstock pipeline for the Bristen power plant is a successful example of this.

The sponge city principle – from pipe-soil-systems to soil-pipe-systems – solutions with ductile iron pipe systems

By Christoph Bennerscheidt

1 Introduction

At least since the recent events of torrential summer rain it has become clear that municipal drainage systems can no longer cope with the volumes of water occurring. Increased surface run-off along uncontrolled flow paths can result in local flooding with devastating damage to infrastructures and buildings **(Figure 1)**.

Figure 1:
Flooding after heavy local rainfall in Dortmund-Marten in 2008
Source: NRW Police

But it is not merely the volumes of water which are causing us problems. The increasing heat levels in predominantly urban areas with a high density of buildings and concrete or tarmac surfaces are also reducing the quality of life in our towns and cities. In order to counteract these effects of climate change, which are sometimes catastrophic in both cases, it is necessary for us to revise our drainage and climate control concepts for cities. In addition to the use of temporary flood-plain areas and the provision of defined flow paths for a safe run-off of rainwater above ground in case of heavy rainfall events – so-called urban flash floods – or increasing the number of green roofs to improve the evaporation rate, the use that the soil is put to in and around the streets of our towns offers as yet unused opportunities for action in order to implement measures against urban flash floods and overheated cities.

2 The sponge city principle

In a report by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) on flooding and heat control by urban development, these measures are referred to as the "sponge city principle". The aim of these changes in use is to make the surfaces of towns and cities more capable of absorbing and storing volumes of rainwater than they currently are in our urban environment. With this type of near-natural rainwater management in towns, green spaces can become the town's natural "coolers" in that they are sufficiently supplied with water. This cooling action can be enhanced by the storage of rainwater, soil-improvement measures and a continuous supply of water for the vegetation. The promotion of the sponge city principle and the development of sustainable storage and irrigation systems are therefore described as central tasks for future climate-adapted cities [1].

The water mangament, too, has recognised the benefits of deliberate water evaporation for cooling cities in climate change as a new part of its remit. This is reflected in the currently available draft of DWA worksheet A 102 [2], for example. It describes measures for implementing the sponge city principle as a future drainage concept for "preserving the local water balance". This includes vegetation with its contribution to evaporation. It also points out that conventional drainage processes, as combined or separate sewer systems, in their "pure form" where they drain away rainwater completely, clearly no longer meet the objective of a local water balance. In future planning projects, they should be gradually converted by the integration of – preferably – decentralised measures of stormwater management into modified systems, provided that there is room for manoeuvre.

The "de-coupling" of surfaces conducive to run-off from the existing sewer system looks like an effective approach for decreasing hydraulic loads on the water management system, improving flood protection and reducing the pollution and hydraulic stress which rainwater outflow causes to bodies of water [2].

Basically, the implementation of the sponge city principle – both in general terms and in terms of the DWA system of rules – means a process of decoupling in inner cities and town centres, where private land, the road space or other public surfaces can serve multifunctional uses for rainwater management, including the evaporation functions offered by vegetation.

3 The de-coupling potential

The de-coupling potential of road surfaces has already been determined on the basis of examples and is described in [3]. In residential streets in the districts of Erle and Resser Mark investigated in the city of Gelsenkirchen, the de-coupling potential achievable in the long-term should be up to 53 % and in the short-term around 22 % **(Table 1)**. As compared with results when determining the potential for de-coupling of roof surfaces, road surfaces offer approximately the same level of de-coupling potential. Both for de-coupling measures on private land and for those on publicly used surfaces, what is needed is motivation in order for the measures to be implemented. On private surfaces this may be by reducing sewage charges. But for implementation in public spaces in the road space there must first and foremost be a readiness on the part of communities and public authorities to make the road space available for infiltration and/or retention systems where necessary [3].

Added to this is the fact that the technical solutions must be organised in such a way that they can be jointly sponsored by the various departments/administrative offices/independent operators in the city and that they meet systems of rules in terms of the materials and components used. Furthermore, preference must be given to solutions which do not result in any restrictions in the usability of the spaces used in this way. Solutions in the space beneath usable road surfaces are to be preferred. However, it must be borne in mind that these spaces are not exactly unused either. Sewers and drains, drinking water and gas pipelines, power cables and telecommunication lines are already installed underground and even now they are competing for space. Added to which are those unplanned underground supply networks, namely the root systems of trees, which apparently interact with sewers and utility pipelines in an uncontrolled manner [4]. Hence, in order to implement the sponge city principle, interdisciplinary cooperation, including urban greenspace departments, is necessary.

Table 1:
A compilation of the de-coupling potential of roads in the Erle/Resser Mark survey area as a result of street-level enquiries [3]

Category of road	Short-term (min.) de-coupling potential		Long-term (max.) de-coupling potential	
	ha	%	ha	%
Residential roads	6.8	22.3	16.2	53.3
Access roads	1.9	13.9	4.8	33.8
Arterial thoroughfares	2.9	7.5	8.4	21.7
All roads	12.1	13.2	31.2	34.1

4 Structural engineering and planting requirements

For solving what, at first glance, looks like an insoluble task there are a few important linking elements. These are, on the one hand, the pore space in coarsely crushed bedding materials for sewers and pipelines which can be built over, can be used as storage for rainwater and at the same time offer trees sufficient space for root growth. On the other hand, there are piping systems which are sufficiently robust and are not damaged by sharp-grained bedding materials. In addition, they must be resistant against external water pressure and show evidence of being root-resistant.

Hence this soil-pipe-system differs from the usual pipe-soil-system where the soil is selected, or even modified, so that it simply ensures optimum bedding for the sewers and pipelines.

Figure 2 (top) shows an example of a coarse-grain crushed substrate, which ensures sufficiently large pore space for rainwater and tree roots, is capable of being highly compacted and, after completion, allows full use of the surface **(Figure 2, bottom)** [5].

When installed in the pavement area, the type of near-surface implementation of the "sponge city principle" shown interferes a very great deal with the pipeline space required by supply companies. This is also illustrated in **Figure 3**. By preference, drinking water and gas pipelines are installed under the pavement. Also, to be found here are the cables of power and communication network operators. Added to which is the fact that cellars are often located directly in the vicinity of the pavement and so, with the introduction of rainwater, planning and construction measures must be put in place to avoid water penetration in cellars. Against this background, it is advisable to implement a method for rainwater management in the pipe trenches of sewers.

Figure 2:
Sponge city principle, implemented in Stockholm –
Top: crushed, coarse-grain substrate with large pore space for storing rainwater and use as space for roots
Bottom: the same area after resurfacing
Source: Embrén, B.

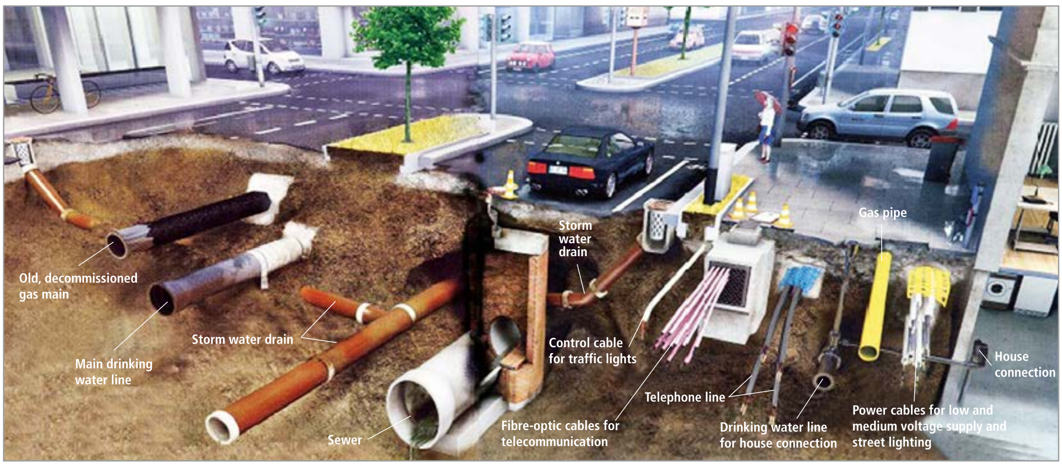

Figure 3:
Example of how the underground space beneath a road is used
Source: RWE-Magazin June 2006, modified by K. Schröder

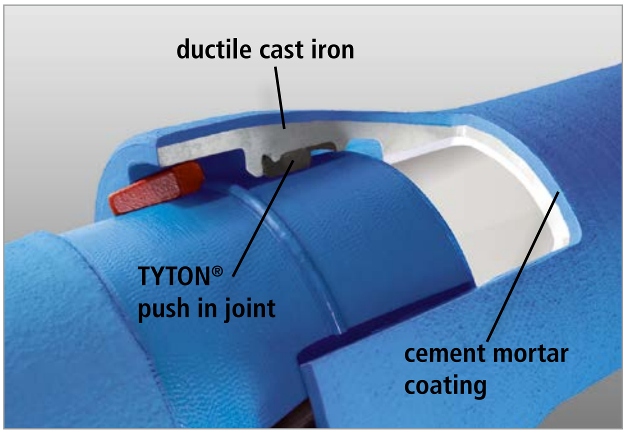

Figure 4:
Left: installation of ductile iron pipes in soil with crushed, coarse-grain stones
Right: example of a ductile iron pipe with TYTON® push-in joint and cement mortar coating to EN 15542 [7], shown in the area of the pipe joint

5 Ductile iron pipe systems – solutions with a robust soil-pipe-system

A piping system which is to be installed in this coarse-grained bedding material is produced in ductile cast iron to EN 598 [6] and protected against corrosion and mechanical stress with a cement mortar coating to EN 15542 [7]. The TYTON® push-in joints used are root-resistant and tight in terms of external water pressure. The cement mortar coating can be laid in crushed bedding material with a maximum grain size of up to 63 mm and individual grains up to max. 100 mm size [8].

Figure 4 (left) shows an example of the installation of such pipes in rocky bedding materials. **Figure 4 (right)** shows a ductile iron pipe with cement mortar coating and a TYTON® push-in joint.

Figure 5 summarises the essential properties of the pipe bedding, the pipeline zone and the main backfill as well as the pipe characteristics during installation of the soil-pipe-system.

The integration of this soil-pipe-system in an urban environment is illustrated in **Figure 6**. The pipe trench with the ductile iron pipes becomes a storage space for rainwater beneath the road. Water from non-polluted surfaces such as roof spaces (apart from roofs covered with copper or zinc) can be directly discharged into this storage space. Polluted rainwater is first pre-treated and then discharged into the rainwater storage space. For pre-treatment, systems available on the market with DIBt certification can be used for example. The water is used either

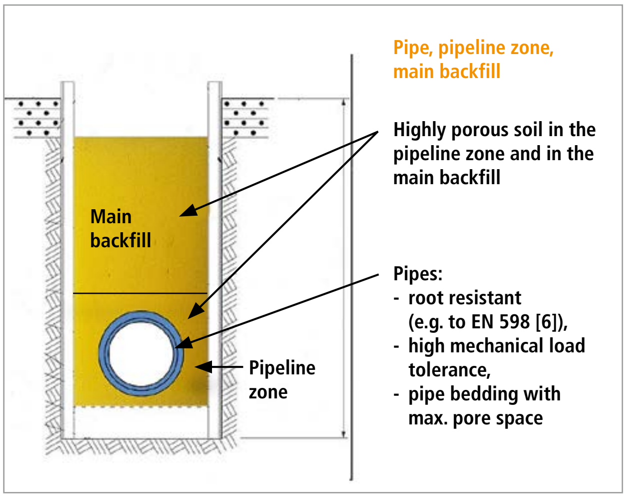

Figure 5:
The sponge city principle in the pipe trench with root-resistant ductile iron pipes with a high mechanical load tolerance. Crushed material with a maximum grain size of 100 mm is used as the highly porous pipe bedding and main backfill

for irrigating the tree roots growing in the pipe trench or it trickles away as in an infiltration system.
The decentralised storage, infiltration and evaporation of rainwater at the place where it falls has a number of positive effects:

- Improvement of the local water balance,
- Reduction of the number and level of combined sewer overflows,
- A decrease in the volume of contaminated rainwater discharged into bodies of water from the separate sewer system,
- Retention of rainwater during heavy rainfall events,

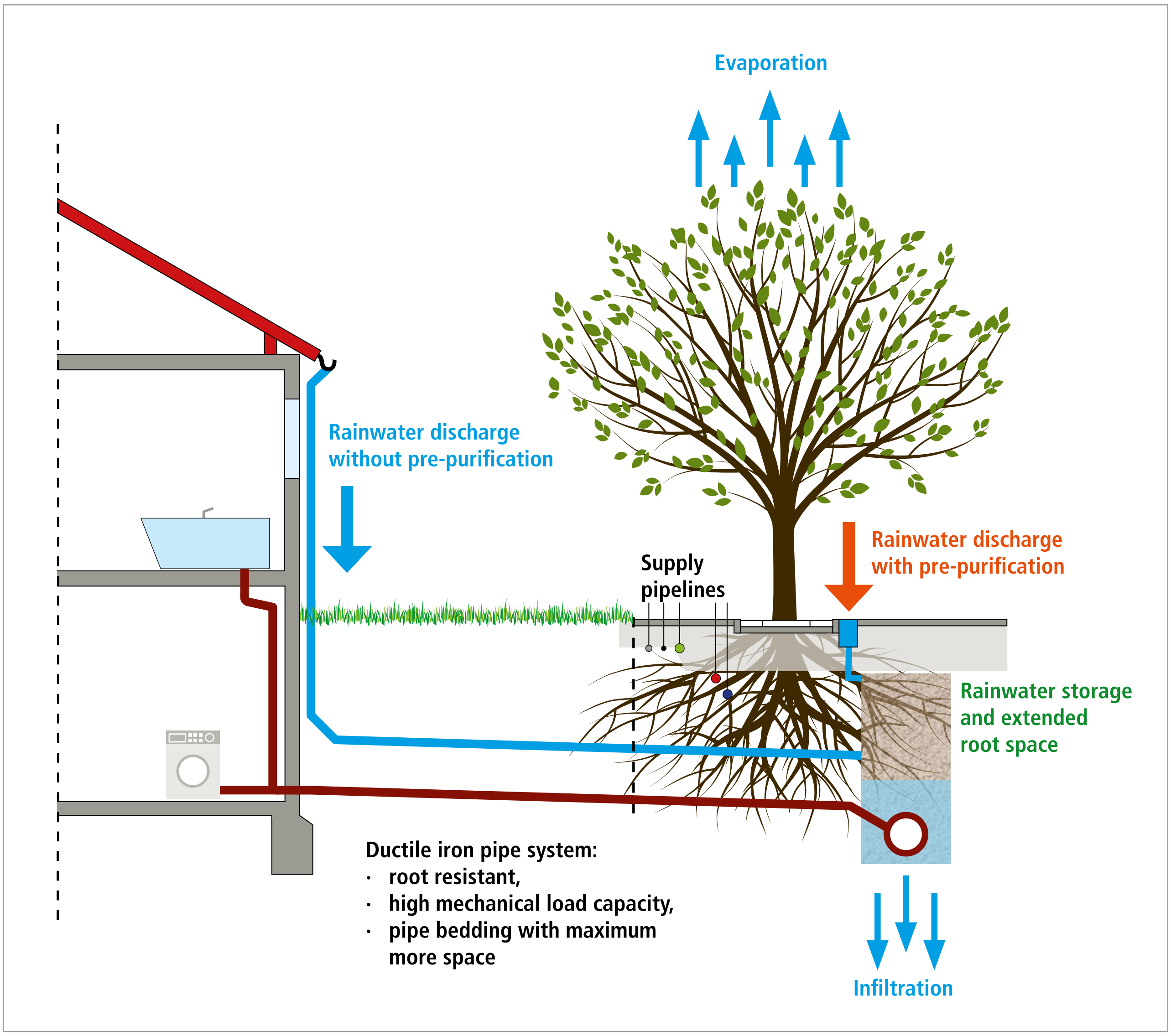

Figure 6:
The sponge city principle in the street space. With crushed, coarse-grain materials with a large storage volume, the soil in the pipe trench becomes a storage space for rainwater and extra space for root growth [9]

- Provision of root space for improved growth of trees in the city,
- Targeted irrigation of city trees with rainwater,
- Increase in the evaporation rate of trees with improved climate conditions in the ambient area,
- Improved protection of property by de-coupling rainwater downpipes from the building's drainage system.

The positive effects on water and property protection and on the city climate are summarised in **Figure 7**.

Figure 7:
Soil-pipe-system – positive effects on water and property protection and on city climate

6 Summary

When building roads and the structures of underground infrastructures, until now it has been the bedding of the pipes and the load-bearing capacity of the structure which are paramount. Highly compacted soils therefore tend to characterise the urban substrate. Wherever pore spaces occurred inadvertently in the ground, these were used by the root system of municipal and private trees, resulting in unintentional interactions with sewers and utility pipelines. Higher requirements for water quality as well as the effects on climate change mean that a change in thinking is necessary and that increased attention needs to be paid to the storage capacity of the soil so that rainwater can be managed where it falls into the soil. It has moreover been established that, with this type of near-natural rainwater management in our cities, green areas can become the city's natural "coolers" because they are sufficiently supplied with water. This cooling effect can be heightened by the planned storage of rainwater, measures to improve the soil and a continuous supply of water for vegetation. The promotion of this so-called sponge city principle and the development of sustainable storage and irrigation systems are therefore a central task for the future of climate-adjusted cities.

To date, construction methods which take account of this principle have only been implemented in isolated cases. The soil-pipe system described here, consisting of crushed, large-grain bedding materials with a large pore space and robust ductile cast iron pipe systems, represent an important stage in the realisation of the sponge city principle. Also, the draft of DWA rule document A 102 [10] can be interpreted as an indication that in future the operators of drainage networks in particular should be involved in the planning, construction and operation of such decentralized rainwater management systems and thus make an essential contribution to dealing with the effects of climate change.

Bibliography

[1] BBSR 2015:
Flooding and heat control by urban development –
strategies and measures for rainwater management in the light of flash floods and overheated cities –
Report of results of the case-study survey "Climate adjustment strategies for flood prevention in different urban areas as a joint community task"

[2] DWA 102, Part A: draft 2016-08

[3] Harms, R.; Schneider, F.; Spengler, B. und Geisler, S.:
Determining the de-coupling potential of road surfaces
Korrespondenz Abwasser 2006 (53) no. 3, p. 244-252

[4] Bennerscheidt, C.:
Background to the data sheet on trees, underground pipelines and sewers.
3R – International,
Edition 07-08, 2014, p. 43–47

[5] Embrén, B.; Bennerscheidt, C.; Stål, Ö. und Schröder, K.:
Optimisation of tree locations –
the Stockholm solution: providing root space and taking advantage of rainwater, alleviating the potential conflict between tree and sewer WWT 7-8, 2008, p. 38-43

[6] EN 598: 2007+A1:2009

[7] EN 15542: 2008

[8] DVGW worksheet W 400-2: 2004-09

[9] DVGW data sheet GW 125: 2013-02
Data sheet text same as DWA-M 162 and FGSV no. 939

[10] Draft DWA-A 102: 2016-10

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Twin-pack ductile iron pipes go round the bend

By Lars Kolbig and Lutz Rau

1 The problem

In the south-east of Berlin, in the Altglienicke/Grünau district, two new pressure pipelines needed to be installed in the context of a reorganisation of the sewage system. After a careful comparison of the options available, Berliner Wasserbetriebe decided in favour of the shortest route for the pipeline. However, this was one which crosses a railway track and a seven-lane main road, meaning that open-trench installation was excluded from the start.

Installation using the HDD process was also excluded, both for space reasons and on account of the railway crossing. So this left a section of protective conduit to be driven for the trenchless installation of the new pipes **(Figure 1)**. However, because of the railway bridge abutments, the protective conduit had to be jacked in at a great depth, otherwise driving in a straight line would not have been possible.

2 The solution

Under these difficult conditions, it was decided to run a DN 1600 reinforced concrete pipe in a curved line passing the abutments of the bridge at a depth of 13 m, at a sufficient and permissible distance from these, by means of manned compressed-air shield tunnelling over a length of 215 m. The two DN 500 and DN 600 utility pipes were then to be drawn into this "protective conduit". As a pressure pipeline, this piping system had to be locked against longitudinal forces and also capable of bending because of the curve in its route. In addition, the pipes had to be laid one on top of the other so that they have the same angular deflections and lengths. Because of the depth of the shafts, the pipes could not be too long and they had to be easy to assemble **(Figure 2)**.

Figure 1:
Installation of a DN 600 ductile iron pipe (the lower of the two) with a BLS® restrained push-in joint

Figure 2:
Lowering a ductile iron pipe ready for assembly

Ductile iron pipes meet this requirements profile 100 %. Therefore, in each case 216 m of DN 500 and DN 600 sewage pipes to EN 598 [1] with BLS® restrained push-in joints and wall thickness class K 9 were used.

3 Implementation

The following conditions need to be met if a challenging construction project like this is to be completed successfully:

- precise planning taking account of all influencing factors,
- the performance of a conscientious approval process with the participation of all utility companies as well as constant and prompt communication with these and all other parties involved,
- exact tendering processes for materials and processes and the contractors providing them,
- selection of a competent and experienced construction company taking account of the corresponding references and economic criteria in the context of a specified schedule,
- consistent supervision of construction measures and the conditions under which they are performed, including acceptance and documentation.

All a matter of course in day-to-day business for Berliner Wasserbetriebe. With an eye to efficiency and performance, even with particular and special construction projects, the Berlin construction company Beton & Rohrbau 2.0 GmbH, with its convincing references, was awarded the contract.

3.1 Manned shield tunnelling of the section of protective conduit

The work began with the sinking of the launch and target shafts to a depth of 14 m, entirely in the groundwater, using bored pile walls in watertight concrete **(Figure 3)**. The bored pile walls had to be watertight in order to withstand the enormous pressure of earth and water and to absorb the forces of the pipe-jacking machine. For static reasons, an elliptical layout was selected for the launch and assembly pits, with the longer axis in the direction of driving.

This layout was advantageous both for setting up the pipe-jacking machine and for assembling the sewage pipes. Finally, the bottoms were concreted so as to be watertight.

To support all the work, a crane runway was erected above the launch and assembly shafts with which all machines, pipes and accessories could be lowered into the pit.

After assembling the machine for the manned shield driving, the bored pile wall was opened up and sealed in the direction of driving.

Continuously manned pipe-jacking is indispensable when it comes to driving a controlled curve deep in the groundwater, especially when inclusions in the soil (boulders) dating back to the ice-age are to be reckoned with.

With manned pipe-jacking there are two workers in a spoil chamber behind the tunnelling shield who control the driving. The soil extracted is conveyed to the surface by piping systems. Obstacles such as large stones and boulders are removed by hand and larger chunks are broken up in situ. To prevent groundwater penetration the spoil chamber is kept pressurised. The men are working under this increased air pressure and therefore need to pass through the airlock installed

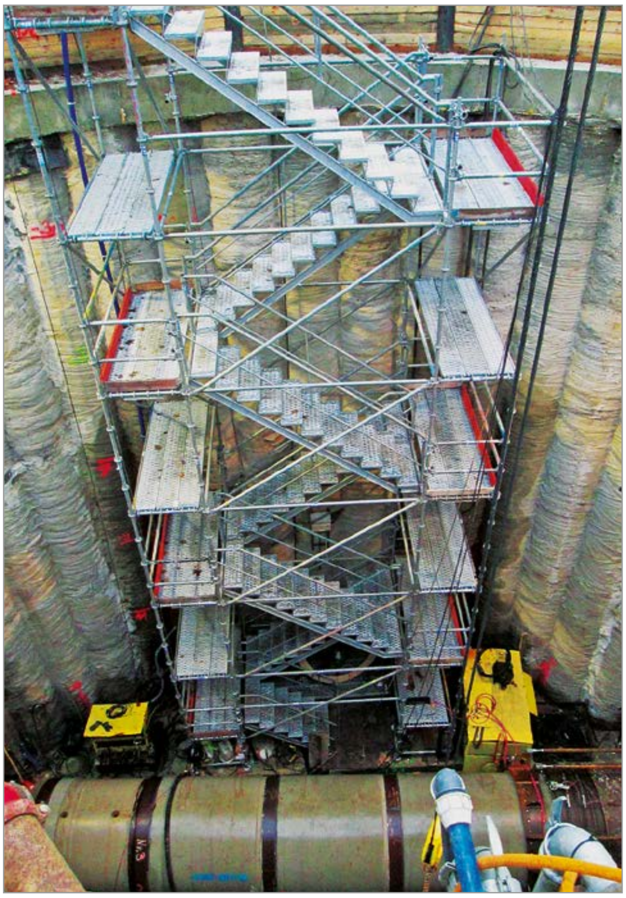

Figure 3:
A glimpse into the launching pit with reinforced concrete jacking pipes.

Figure 4:
View inside the lock chamber

in the machine before and after work **(Figure 4)**. Just like divers, they have to spend a certain amount of time in the airlock to allow for pressure equalisation.

Without this pressurisation, the section being tunnelled and the launch pit would be flooded. Between the reinforced concrete jacking pipes and the bored pile wall, some complex sealing is required. The shield machine and the airlock are pushed forward from the launching pit by the jacking pipe segments as the tunnelling progresses.

The climax is always reaching the target pit accurately and opening up the bored pile wall. This worked out here perfectly.

3.2 Installation of the ductile iron pipes

In order to be able to pull in both pipes one on top of the other, the following parameters needed to be taken into account:

- Regardless of the process (pushing or pulling in) the horizontal position of the pipe string in a curve must be ensured so that the pipes are not drawn out of the curve or pushed into the curve.
- When subsequently sealing the protective conduit, the stability of the vertical position must also be considered.
- The preferred direction of installation for restrained pipes is always pulling because in this way the push-in joints are already extended and locked during the pulling-in operation.

Therefore, a U-rail was positioned in the bottom of the inside radius of the casing pipe section along which the pipe clamping frames fitted with rollers were then run. The pipe string was also supported on rollers on the clamps along the springing line of the protective conduit so that it could not tip over during the pulling-in process. Pipe clamps on the frames took up the pipes and ensured their smooth insertion. There was no connection between one frame and the next. The pulling forces were only transmitted via the restrained push-in joints of the pipes.

The BLS® push-in joint is characterised by its ease of assembly and the high permissible tractive force, even during angled insertion. Therefore, the BLS® push-in joint has proved to be of great value for all installation processes and high-pressure applications.

This thrust resistance is achieved in the following way: the spigot end of the pipe has a welding bead applied around the circumference of the pipe in the factory, which is firmly and deeply anchored in the wall of the pipe by its root. In the socket section, there is a (thrust protection) chamber with two "windows" arranged on the front of the socket. Once spigot end and socket have been put together, the cast-iron locking segments are inserted through these windows and arranged around the circumference of the pipe. And dismantling the pipes is just as easy as assembly: after extracting the locking segments the joints can easily be released again, e.g. when dismantling fittings after pressure testing or when dismantling the pulling heads; this is where the BLS® system has clear advantages over other systems.

Traction heads are mounted on the spigot ends (also BLS® system) of the first pipes in each case **(Figure 5)**. The tractive forces are taken up by a traction-head string construction. The possible tractive loads of 86 t or 120 t with a permissible angular deflection of 2° or 3° are guaranteed by the manufacturer, although with this project, with only 5 t, there was a great deal of capacity to spare and hence a high degree of safety. The traction string construction ensures the balanced transmission of the tractive forces to both pipe strings. The construction was pulled by a traction cable. In this process the DN 600 pipe was beneath the DN 500 pipe **(Figure 6)**. It was also important to make sure that the pipe lengths were the same so that the socket joints linking them were always directly aligned. The pipes were bundled together for fixing onto the clamp construction and then assembled, extended/locked and screwed down **(Figure 7)**.

The joints are wrapped with shrink-on sleeves because the surrounding space in the protective conduit was later to be filled/sealed.

For the closure and flange transition in the shafts, the pipe manufacturer supplied the appropriate fittings from the BLS® system (flanged spigots and sockets, [2]) and also the traction heads.

During the assembly of the traction heads and the first pipe joints, the construction company was supported by an engineer from the pipe manufacturer, who was also present for the application of the welding beads onto pipes which were shortened on site **(Figure 8)**.

Figure 5:
A view down into the launch pit during assembly of the traction head

Figure 7:
Pulling in the prepared pipe bundle

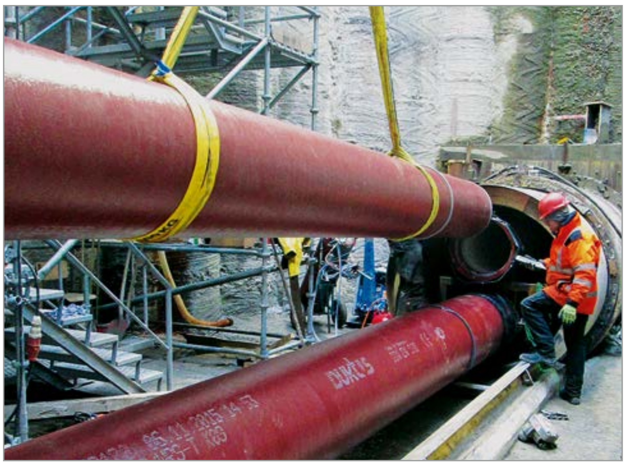

Figure 6:
Assembling the ductile iron pipes in the launch shaft

Figure 8:
An application engineer from the pipe manufacturer applying a welding bead

After successfully completed pressure testing and camera inspection the shafts were partially filled with concrete; hence they also served as thrust blocks for the rising conduit arm.

4 Concluding thoughts

The ever more densely entwined infrastructure of today's cities requires some new thinking as regards the utilisation of installation space and the application of modern construction methods if it is to satisfy all aspects of sustainability. In order for challenging construction projects to be economically justified it is always essential to aim at an operationally secure, problem-free working life which is as long as possible.
The best chain of competence consists of

- excellence in prudent planning and preparation,
- competence in performance by an experienced specialist construction company,
- experience in construction supervision and
- durable materials with high safety margins.

Bibliography

[1] EN 598: 2007+A1:2009
[2] E-Book, Chapter 6
Download: www.eadips.org/e-book-d/

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Root resistance of ductile iron pipe joints

By Christoph Bennerscheidt

1 Introduction

“Root penetration into sewers and drains” is recognized as an obstruction to flow in the context of the camera inspections regularly performed on the inside of pipes. In private drains, root penetration may only be noticed at a late stage when blockages and backing up occur, along with the resulting consequences. In public sewer systems, root penetration is one of the most frequent causes of damage [1]. In both private drains and public sewer systems, these sections of pipeline are considered not to be tight.

2 Root growth and root pressure

The reasons why tree roots tend to grow into drains and sewers has been researched over the last 15 years. An important result of the “Root penetration into sewers and drains” research project [2] has been the development of models which can describe the penetration of roots in the area of sewers and pipelines. Based on results from numerous excavations, the density trap model and the oxygen model have been developed and described; they are useful for describing the growth of roots in the underground space. In the context of a further research project [3], root pressures of primary roots and contact pressures of push-in joints were determined on different DN 150 nominal size pipe systems made of vitrified clay, plastics and ductile cast iron. No choice could be made of the pipe joints – e.g. in the form of the maximum socket gap – in which the minimum contact pressure could be expected, as the range of contact pressures needed to be identified. This fact led the Association to have the contact pressures in the TYTON® push-in joint system determined. With the help of the following criteria such as

- the density trap and oxygen models,
- the investigation results on the root pressure of the primary roots of different trees,
- the contact pressure investigations on push-in pipe joints in the context of [3] and
- measurements on the TYTON® push-in joint system with a maximum socket gap

it was possible to estimate the root resistance of the TYTON® push-in joint system.

3 The density trap model

The entire environment of buildings and their infrastructure is a ground space which has been produced anthropogenically. In contrast to natural ground it often has a lower compaction level and larger pore spaces. The differences in density affect the direction of growth of the root tip. The elasticity of the calyptra (root tip) means that the roots grow in the direction of the substrate which is easiest to penetrate **(Figures 1 and 2)**. The growth of roots back into an area of high compaction or poorer penetration conditions can be excluded as a rule. The roots are “trapped” in areas of soil with greater penetration potential. The annular gap or space before the sealing element can also, depending on the pipe joint, be an area which the roots can easily access. They can grow there for several years before they finally penetrate inside a pipeline. To do this, they have to overcome the contact pressure of the sealing agent.

Figure 1:
Tough roots in the utility trench of a telecommunications line

Figure 2:
Fine roots in the utility trench of a gas pipeline
Source: Heidger, C.

4 The oxygen model

The availability of oxygen in the soil has a great influence on root propagation. All plant organisms need oxygen to sustain their metabolic processes. The sealing of urban soils has the consequence that oxygen is seriously restricted from entering the soil. Sewers are usually operated as gravity pipelines and are sufficiently ventilated via maintenance and inspection openings (manholes). The major proportion of the pipeline is filled with air. With cast seals, cracks can occur in the casting material due to shrinkage. In this way, the oxygen contained in the air can get into the environment of pipes and pipe joints in the soil. When planning sewer systems, no consideration is given to the gas permeability of pipes and pipe joints. However, it can also influence the growth of roots with newly installed sewage pipes. With pipe materials which are not gastight, oxygen can leak out even if the pipelines are intact. According to the oxygen model, roots grow towards the source of oxygen and so find the pipe joint.

This model (oxytropism) is supported by the results of [4]. On the roots of pea seedlings (Pisum sativum L.) it was able to be demonstrated that these followed an oxygen gradient in the direction of the higher O_2 concentration. Based on this, it was the aim of the "Root penetration into sewers and drains – supplementary project" research project [3] to prove the causes of root growth into pipelines scientifically and to describe the mechanisms behind the penetration of a root into the pipeline and the interactions between pipe properties and root penetration. In addition, proposals were to be developed for testing procedures to illustrate the mechanical and biological processes involved in root penetration realistically so that pipe joints can be evaluated in terms of their resistance to root penetration. This included a description of the differences in the growth behaviour of various tree species as characteristics of different root systems. One particular point of focus was the interaction of roots with different DN 150 pipe joints and mechanical trials to investigate root resistance. The results of these investigations are summarised in Section 9, Investigations and results.

5 Practical examples

The influence of the pore space on root growth can be seen in **Figures 3 to 6**. For the tests at the Botanical Gardens of Ruhr University Bochum shown in **Figures 3 to 5**, an artificial layering of two substrates with different porosity levels was set up in planters. Compost of the type used for container cultivation in the Botanical Gardens of Ruhr University Bochum was selected as the substrate with a high pore proportion and good root penetration characteristics. Bentonite was selected for the reproduction of soil areas

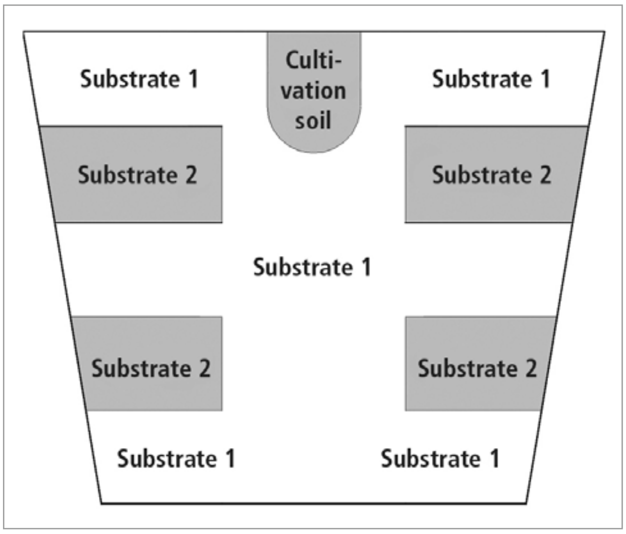


Figure 3:
Schematic longitudinal section through a planter
Source: Schmiedener, H.

Figure 4:
Planter opened down the side – no roots are to be seen in the layers of bentonite
Source: Stützel, T.

Figure 5:
Planter cut open – roots flushed off with water. The roots have not grown into the bentonite.
Source: Stützel, T.

Figure 6:
Roots at a depth of 7 m, which have grown down to this depth because of the good oxygen supply
Source: Schmiedener, H.

with a low pore proportion and poor root penetration characteristics. The material used consists of clay minerals with a mean particle size of 0.063 mm. The small size of the particles has the result that the spaces (soil pores) needed for root growth with a size from 100 µm upwards are not available [5]. The substrates were applied alternately in horizontal layers around a central column of one of the substrates. The layer structure can be seen in the schematic longitudinal section represented in **Figure 3**. **Figure 4** shows a planter opened up on one side.

A simple glance at this picture gives a hint that no roots have grown into the bentonite with low pore space, which was confirmed after cutting through the planter including the soil it contained and flushing off the roots with water. The roots had spread through the compost down to the bottom of the planter **(Figure 5)**. Between the layers of bentonite, they had in fact reached almost as far as the vertical edge of the planter [2].

This laboratory-simulated behaviour of root growth was confirmed in practice. The root system shown in **Figure 6** was found at a depth of 7 m. The roots had spread along a service pipeline to a house, connected via the fitting shown to the sewer system. They continued to grow into the main sewer pipe trench and into the space around the sewer. At this depth, the growing root system needs a sufficient supply of oxygen. There is reason to believe that this oxygen came from the non-gastight socket joints of the house connection pipeline and the main sewer, along the lines of the oxygen model.

6 Characteristics of different root systems

The possible effects of differences in the anatomical structure of roots were investigated with the help of root pressure measurements on primary roots. Basically, a lower root pressure was measured with gymnosperm roots (coniferous trees) than with angiosperm roots (broad-leafed trees). The peak values for the root pressure of gymnosperms varied between 4.0 bars for araucaria roots (Araucaria araucana) and 8.8 bars for pine roots (Pinus pinea). The root pressures of angiosperms (broad-leafed trees) varied as well. As the lower peak value, 8.8 bars were measured for robinia roots and as the upper limit, a brief value of 11.9 bars was recorded for oak tree roots. On average root pressures are between 4 bars and 8 bars. The results of the root pressure measurements are summarised in **Table 1**.

Table 1:
Root pressure under ideal growth conditions for the seedling roots used –
at every point there was a continuous supply of water and oxygen for the roots

Species	Measurement series	Measurement period [h]	Maximum pressure [bars]	Average value [bars]
Pisum sativum L./ Pea	1	62.5	4.9	4.07
	2	62.5	**5.9**	
	3	62.5	2.5	
Quercus robur L./ Common oak	1	50.0	1.2	8.42
	2	50.0	5.9	
	3	64.0	11.9	
	4	46.0	10.8	
	5	46.0	**12.3**	
Robinia pseudoacacia L./ Lack locust tree	1	58.0	**8.8**	6.43
	2	58.5	8.4	
	3	48.0	6.7	
	4	48.0	6.5	
	5	25.0	3.7	
	6	22.0	4.5	
Pinus pinea L./ Pinr/Italian Stone Pine	1	700.0	3.6	6.28
	2	700.0	8.8	
	3	670.0	**9.8**	
	4	670.0	2.9	
Araucaria araucana (MOLINA) K.KOCH/ Monkey puzzle tree	1	530.0	**4.0**	4.0

7 Pipe joints

Sewage pipes are most often connected together by means of push-in joints with elastomer as the gasket. As compared with other systems they offer the advantage that they are comparatively easy to assemble even under difficult site conditions. In recent years, the development of these joints has been advanced and optimised in terms of constructional criteria. The most commonly used socket joint for ductile iron pipes is the TYTON® push-in joint **(Figure 7)**. This is standardised in the range DN 80 to DN 1400. Since its introduction onto the German market in 1957 it has proved itself a million times over in drinking water, raw water and wastewater pipelines. The essential dimensions of this joint are determined in DIN 28603 [6] for nominal sizes DN 80 to DN 1400. The sealing function of the TYTON® push-in joint is performed by a profiled gasket consisting of a mixture of softer rubber (sealing part) and a harder rubber (retaining part) [7].

The STANDARD – push-in joint **(Figure 8)** is comparable with the TYTON® push-in joint in its constructional concept and its function. In Germany, its joint dimensions are determined in DIN 28603 [6], (Form C), from DN 80 to DN 2000. The gasket consists of rubber with a single hardness grade.

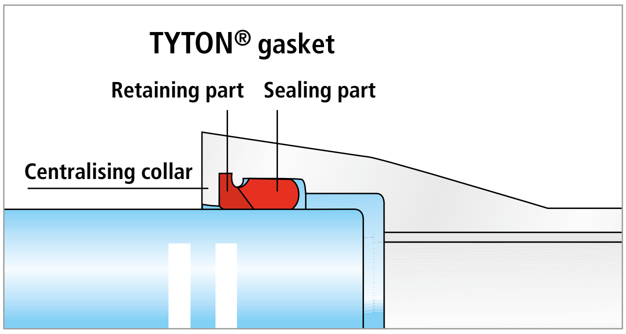


Figure 7:
Push-in joint for ductile iron pipe system, TYTON® system

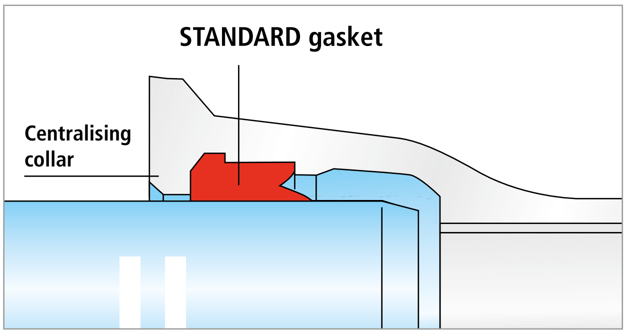


Figure 8:
Push-in joint for ductile iron pipe system, STANDARD system

8 Interaction between pipe joints and roots

In order to test pipe joints, load situations such as those which may occur in the pipe trench are simulated in laboratory tests so that pipe and pipe joint quality are ensured. Roots which grow into pipe joints and result in leakages represent an as yet undefined burden for pipe joints. The load case represented by root growth was described for the first time in the context of [2]. According to this, roots do not only penetrate pipe joints which lack tightness. Indeed, according to the generally accepted rules of technology, they can overcome "root-proof" pipe joints, so the assumption that "watertight pipe joints mean root-tight pipe joints" does not apply in all cases. Results of investigations in Sweden [8] and Australia [9] confirm these observations. The strategies by which roots can vanquish a pipe joint have already been described in [2]. Particular importance is placed on the pipe material used, the geometric design of the pipe joint and the elastomer gasket applied. The sum of the properties of these individual components influences the growth behaviour of the roots in the area of pipe joints. Additional factors, such as the supply of the roots with oxygen via the piping system (diffusion tightness of pipe materials and push-in joints), are to be taken into account here.

9 Investigations and results

In the context of [3], the contact pressures were determined on a total of eleven different push-in joints of nominal size DN 150 and OD 160. This included three push-in joints for vitrified clay pipes, four for PVC pipes, three for PP pipes and one push-in joint for ductile iron pipes. The results of the contact pressure tests on the DN 150 TYTON® push-in joint, without shear load and under the influence of a shear load, are shown in **Figure 9** (Table 18 in [3] gives all the results). As an average contact pressure without the effect of a shear load, a value of 22.2 bars was determined for the TYTON® push-in joint system. Under a shear load an average contact pressure of 17.5 bars was produced on the non-loaded side of the TYTON® push-in joint system.

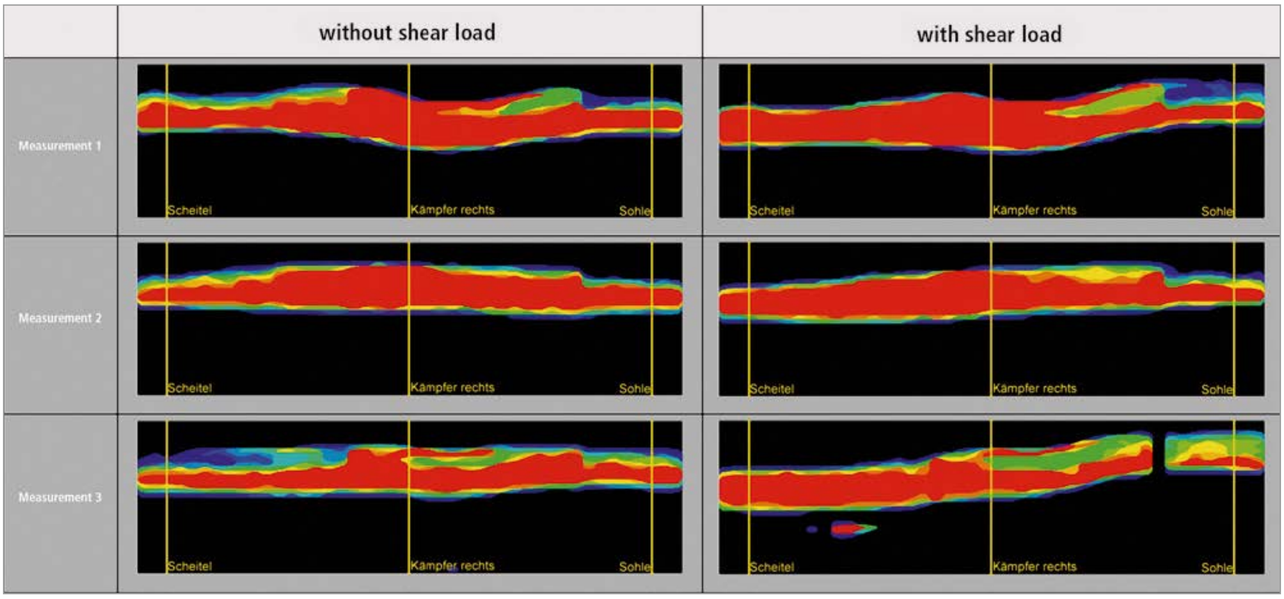
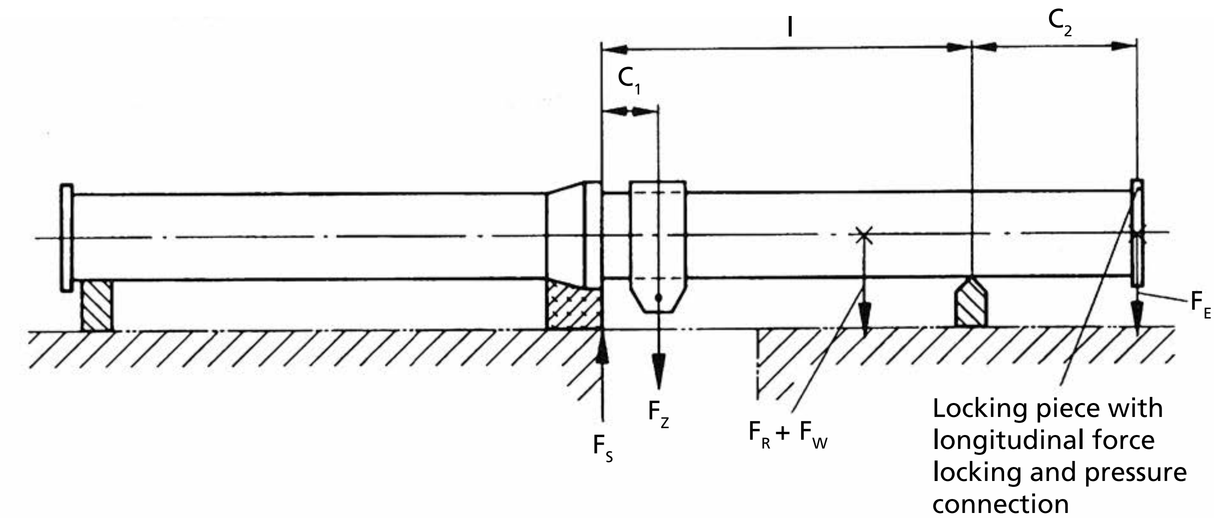


Figure 9:
Measuring the contact pressure using pressure measurement film. Pipe joint of a DN 150 ductile iron pipe with TYTON® push-in joint without shear load and with shear load to EN 598 [10].
Substantial contact pressure in the area of the pipe bottom:
Measurement 1) without shear load effect 24.8 bar, with shear load effect 21.2 bar,
Measurement 2) without shear load effect 23.9 bar, with shear load effect 20.4 bar,
Measurement 3) without shear load effect 17.8 bar, with shear load effect 10.8 bar.
Mean values for contact pressure without shear load effect 22.2 bar, with shear load effect 17.5 bar ([3], Fig. 35)



F_E	Dead weight of locking piece
F_R	Dead weight of pipe
F_S	Shear load
F_W	Weight of water
F_Z	Additional load
l	Distance between elastomer gasket and right support
C_1	Distance between elastomer gasket and load introduction point for F_Z
C_2	Distance between right support and load introduction point for F_F

Figure 10:
Shear load testing for pipe joints in sewers and wastewater pipelines with elastomer gaskets as per [11]

10 Penetration risk and root resistance in the light of the Technical Rules

The root resistance of pipe joints was considered to be proven in Germany in accordance with DIN 4060 [11] if the pipe joint under shear load had withstood tightness testing under positive and negative pressure **(Figure 10)**. This was under the assumption that roots can only penetrate pipe joints which are not tight.

This changed on the basis of the research results described in [2] and [3] and has been taken into account with the publication of the interdisciplinary rules on "Trees, underground pipelines and sewers", appearing with the same text as DWA-M 162 [12], DVGW data sheet GW 125 and FGSV 939.

As an important change, in the two chapters Tightness and root resistance ([12], chapter 5.5) and Pipe joints ([12], chapter 5.6) a risk of penetration for tight pipe joints is described for the first time ([12], chapter 5.5):
"Roots can grow not only into leaky pipes and pipe joints but also tight pipe joints which do not offer sufficient resistance to the roots."

It goes on to state:
"With new constructions and the correct manufacture of pipe joints (e.g. to DIN EN 1610/ DWA-A 139 for sewerage) it can be assumed that the danger of root penetration into the pipeline is slight. In order to increase resistance to root penetration, additional constructional safety measures can be adopted ([12], chapter 7)".

By way of additional constructional safety measures, [12], chapter 7.2.2 describes measures which are taken directly in the area of underground pipelines and trenches: so-called passive protective measures. Among the passive protective measures are:

- the use of low pore space filling material in the pipe- or pipeline trench,
- the installation of casing pipes (protective conduits) around the pipeline,
- the installation of plates or sheetings in the pipe trench,
- the choice of root resistant pipe joints, other installations.

Therefore, from [12], chapter 5.5 of the data sheet "Trees, underground pipelines and sewers" it is possible to deduce the risk of penetration into push-in joints, even where the pipe joint has been assembled correctly. A push-in joint with the lowest risk of penetration, or none at all, would then be classified as root resistant according to [12], chapter 7.

11 Measuring the contact pressure on pipe joints

The geometry of the sealing agent and the resulting influence on the contact pressure produced remained unconsidered in shear load testing [11]. It is only the short-term strain on the sealing agent which has been demonstrated in tests. No attention was paid to changes in the properties of the elastomer such as the reduction of contact pressure under more enduring shear load.

In EN 14741 [13] a testing process is described for determining the long-term sealing behaviour of elastomer gaskets by extrapolation and estimation of the sealing pressure after 100 years. The process reads as follows in EN 14741 [13]:
*"The sealing pressure in a joint is estimated by measuring the pressure required to lift the gasket in each of the three PTFE tubes which are distributed evenly around the circumference of a joint between the rubber gasket and the outside wall of the spigot end or, where applicable, the socket **(Figure 11)**. In a temperature-controlled environment and at increasing time intervals, nitrogen or air is forced through three flexible PTFE tubes at a constant flow velocity of 120 ml/min. The nitrogen or air pressure p required to achieve this flow velocity is measured. The pressure p_t is measured within a period at increasing intervals of time. The extrapolated regression lines for p_t are used in order to calculate the estimated values of p_x after 100 years and p_y after 24 hours."*

PTFE (polytetrafluoroethylene) tube:
stretched tube which is normally used as shrink tubing. The original diameter and the original wall thickness after shrinking are determined normally. It should be noted that the dimensions in the stretched state are not normally determined. The wall thickness determined and the diameter determined are to be checked carefully. The limit deviations stated should be considered as a guideline for suppliers.

p_t:
the pressure measured [bars] in the PTFE tube with a flow velocity of 120 ml/min during time t [hrs]

p_x:
extrapolated pressure after 100 years [bars]

p_y:
calculated pressure after 24 hours [bars]

The test set-up is shown in **Figure 11**. The investigations are carried out according to EN 14741 [13] without the influence of shear loads. **Figure 12** shows a typical procedure for contact pressure measurements and subsequent extrapolation by way of example.

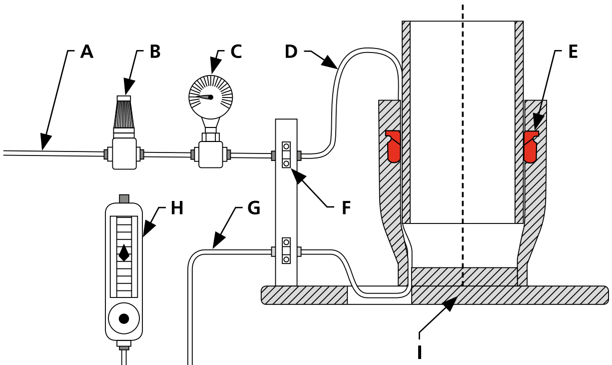


Figure 11:
Measurement of contact pressure, taken from [2], published in [14]

12 Evidence of the root resistance of TYTON® push-in joints

The test below shows a way in which the root resistance of push-in joints can be demonstrated based on EN 14741 [13] with a modified test for determining the long-term sealing behaviour of elastomer gaskets by estimating the sealing pressure.

The following conditions must be met for the application and subsequent interpretation of the results:

- The pipe materials and push-in joints used in the context of the tests are demonstrably diffusion-tight [15], so that there is no oxygen supply to the roots in the pipeline trench via the pipe system.
- The minimum possible contact pressures are determined for the push-in joint to be tested. For this purpose, the boundary conditions for the type testing of ductile iron pipe joints, for example, are to be observed. Push-in joints with a maximum joint annulus to EN 598 [10] are used, loaded with a shear load in the aligned position.
- Even the wall thickness of the means of measurement used (PTFE tube) can influence the contact pressure measurement. In order to take this into account, before the test the diameter of the spigot end is to be reduced by a corresponding amount (e.g. by "turning").
- The tests are carried out representatively for the DN groups described in EN 598 [10] on DN 200, DN 400 and DN 800 push-in joints.

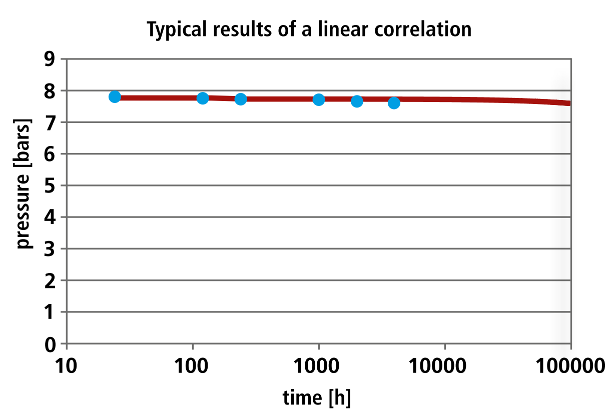


Figure 12:
Typical course of contact pressure measurement with subsequent extrapolation

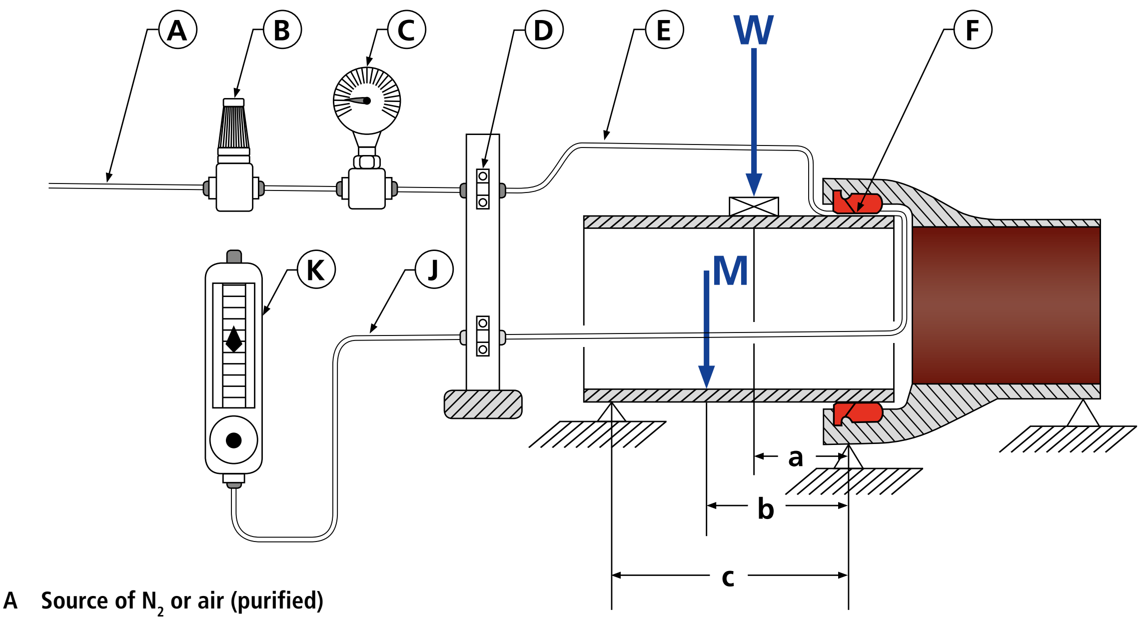


Figure 13:
Schematic representation of the test set-up based on EN 14741 [13]: push-in joint with a maximum joint annulus. Circumference of the spigot end reduced by the amount of the measurement device (PTFE tubes). Measurement with four PTFE tubes which are inserted into the shear-load-relieved area of the pipe joint (drawing EN 14741 [13], supplemented by J. Rammelsberg)

The test set-up is shown in **Figure 13**.

Notwithstanding the specifications in EN 14741 [13] four, and not three, PTFE tubes are positioned on the non-loaded side of the coaxially-mounted and shear-force loaded joint represented in **Figure 13** between the seal and the surface of the spigot end according to **Figure 14** at positions 0°, 45°, 90° and 300°. After this, the pressure required to lift the seal is measured according to EN 14741 [13] at the intervals stated.

The root resistance of the push-in joint tested is considered proven if the contact pressure between the elastomer seal and the spigot end of a push-in joint is greater than the average pressure of the root tips and therefore the width of the sealing surface can also be assumed to be sufficiently large to cut the root tips of from the oxygen available in the pore space of the soil (diffusion tightness).

This is the case with the TYTON® push-in joint system and the STANDARD system if the pressure after 100 years, extrapolated according to the process described here based on EN 14741 [13], determined on push-in joints with a maximum joint annulus as per EN 598 [10], is on average greater than 7.0 bars.

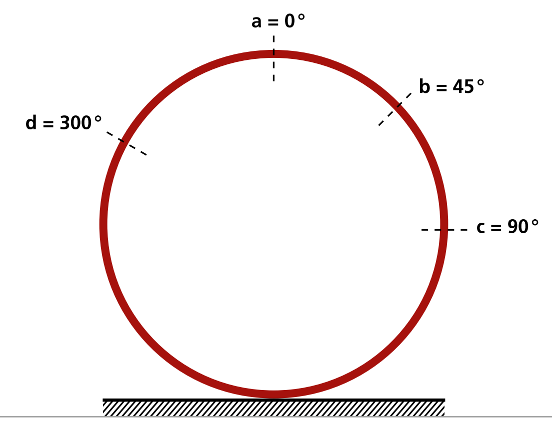


Figure 14:
Arrangement of the test tubes

With the process described here, tests were carried out to estimate the sealing pressure on push-in joints from the TYTON® system, nominal sizes DN 200 and DN 400 [16]. The real test set-up is shown in **Figures 15 and 16**.

For the TYTON® push-in joint DN 200, a mean value of 7.67 bars after 100 years was estimated and for push-in joint system DN 400 the estimated mean value was 7.76 bars after 100 years. In the result, the push-in joints tested were classified as root resistant.

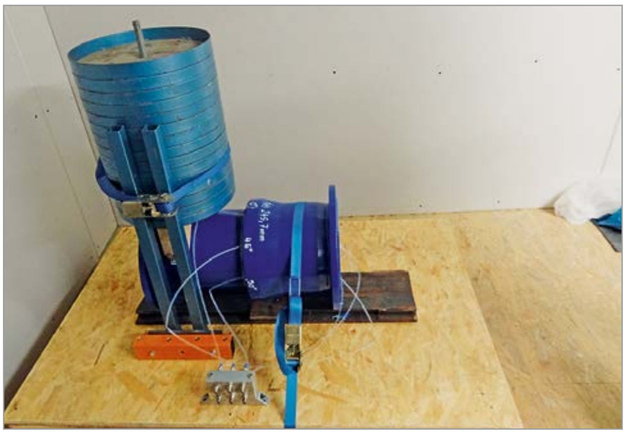


Figure 15:
Test set-up for a DN 200 TYTON® push-in joint based on EN 14741 [13] at the IRO Institut für Rohrleitungsbau an der Fachhochschule Oldenburg e. V.

Figure 16:
Test set-up for a DN 400 TYTON® push-in joint based on EN 14741 [13] at the IRO Institut für Rohrleitungsbau an der Fachhochschule Oldenburg e. V.

The details of the measurements, results and evaluation are included in test report no. G 32 980 dated 14.02.2013 – Determination of the long-term sealing behaviour of TYTON® push-in joints with elastomer gaskets by estimating the sealing pressure based on EN 14741 [13] – Iro GmbH Oldenburg [16]. It can be viewed and/or downloaded at www.eadips.org/gutachten/.

13 Summary and outlook

The reasons for the penetration of tree roots into wastewater pipelines and sewers have been researched in the last 15 years. The following should be highlighted as significant results:

- density trap model,
- oxygen model,
- possibility of root penetration into watertight joints,
- influence of joint construction and gasket geometry,
- diffusion tightness of the material for pipe and gasket,
- level of the contact pressure of the gasket,
- consequences for the Technical Rules.

Ductile iron pipe systems, including their push-in joints, are demonstrably diffusion-tight, meaning that a supply of oxygen to the root system in the pipe trench can be excluded and hence a significant stimulus for root growth is lacking. Furthermore, in the context of [2] it has been shown that the contact pressures and contact pressure surfaces of ductile iron pipe joints are way above the average root pressures which were also determined experimentally.

In the product standards for ductile iron pipe systems [10], the usual function tests for the tightness of movable pipe joints are carried out with a maximum joint annulus under the simultaneous effect of a shear load. In the revision of product standard EN 598 [10] the requirement for and testing of root resistance is included as an additional element in the standard in the form of a long-term test.

On the basis of these results, there are applications in the underground space which require a root-resistant push-in joint. One of these applications is described in the article “The sponge city principle – from pipe-soil-systems to soil-pipe-systems – solutions with ductile iron pipe systems” starting on page 11.

Bibliography

[1] Stein, D. and Kaufmann, O.:
Damage analysis on concrete and vitrified clay pipe sewage systems in the Federal Republic of Germany – West Korrespondenz Abwasser
1993-02

[2] Stützel, T. et al:
Root penetration into sewer systems and drains -
Ruhr University Bochum in cooperation with IKT – Institut für Unterirdische Infrastruktur gGmbH
Research report July 2004
Download: www.ikt.de/website/down/f0108langbericht.pdf

[3] Stützel, T. et al:
Root penetration into sewer systems and drains –
Supplementary project
Ruhr University Bochum in cooperation with IKT – Institut für Unterirdische Infrastruktur gGmbH
Final research report June 2007
Download: www.ikt.de/website/down/f0160langbericht.pdf

[4] Porterfield, D. M. and Musgrave, M. E. (1998):
The tropic response of plant roots to oxygen - Oxytropism in Pisum sativum L.
Planta 206 (1): 1–6
Quoted in Streckenbach, M.:
Interactions between roots and technical infrastructure underground – Principles and strategies for avoiding problems
Dissertation 2009-06
Download: www.streckenbach.org/projekt_jul_2009.html

[5] Kuntze, H., Roeschmann, G. and Schwertfeger, G.:
Soil science
Thieme-Verlag, 5th edition
1994

[6] DIN 28603: 2002-05

[7] E-Book 10.2015,
Chapter 8
Download: www.eadips.org/e-book-e/

[8] Ridger, D. u. a.:
Evaluation of testing of concrete and PVC pipes
Published in: Final scientific report of COST Action C 15 “Improving relations between technical infrastructure and vegetation”
2008

[9] Whittle, A.:
The resistance of elastomeric seal pipe joints to tree root penetration
2003-07

[10] EN 598: 2009-10

[11] DIN 4060: 1998-02

[12] DWA-M 162: 2013-02

[13] EN 14741: 2006-05

[14] Scharwächter, D.:
Long Term tightness of sealing joints in non-pressure plastic pipe systems
Plastic Pipes XI
2001

[15] Wolf, W.:
fgr volume 10 (1975), p. 55 et seq

[16] Rolwers, S.:
Test report no.: G 32 980 –
Determining the long-term tightness behaviour of TYTON® push-in joints with elastomer gaskets by estimating the sealing pressure based on EN 14741 [13]
Iro GmbH Oldenburg
2013-02-14

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Fusion Bonded Epoxy Resicoat R4® has been protecting buried cast iron components against corrosion for more than 25 years

By Torsten Leitermann

1 Introduction

Since the 1980s, Fusion Bonded Epoxy (FBE) has been the dominant thermoset polymer coating material for the long-term protection of steel and cast iron components in pipeline networks where the operating conditions are corrosive. So FBE comes into everyday use for the external coating of onshore and offshore pipes, the internal coating of oil and gas conveyor pipes (tubing or casing) or in the field of the reinforcement steel coating for exposed construction projects such as dams and barrages, tunnels or bridges. Equally, chemical and wastewater tanks as well as heavy-duty valves and fittings in cast iron or steel for the municipal and industrial gas and water sector are protected with FBE.

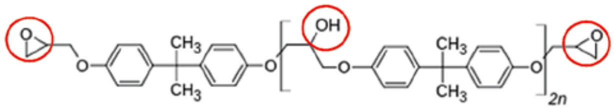
2 The properties of FBE

The success of reactive crosslinking FBE can be put down to the sum of its functional properties which characterise this material and make it predestined for use in the field of corrosion protection: it combines an outstanding adhesiveness to the substrate with high dielectric strength, resistance to chemicals and deformation and heat pressure resistance. Hence FBE offers a profile of technical and functional characteristics which basically differentiates it from reversible-deformable thermoplastic materials such as polyamide, polyethylene/polypropylene or modified polyolefins.

3 Production of FBE powder

For the production of FBE powder, solid – in other words solvent-free – epoxy resins and corresponding epoxy curing agents are pre-mixed together with other recipe components, dispersed (kneaded) in the extrusion process and then ground to a fine powder.

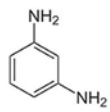
In a simplified representation, the chemical structure of an epoxy resin film looks something like this:



Epoxy
(functional OH hydroxyl groups and terminal $CHOCH_2$ epoxy rings)

+

Epoxy curing agent
(in addition to $–NH_2$ other reaction groups are used)



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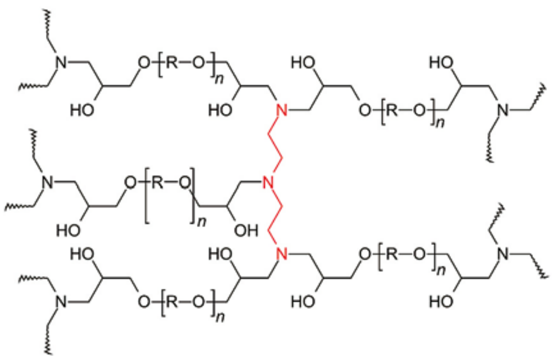

FBE polymer matrix (schematic)

With the help of accelerators (catalysts) the appropriate reaction kinetics are adjusted to the processing method to be used. A variety of inorganic fillers is used for the controlled adjustment of mechanical properties such as impact strength, bending properties or elongation. Also, the barrier effect of the coating film against diffusion can be increased. Inorganic or organic pigments produce the desired colour adjustment. Additives are used in low doses and these are special preparations which help control behaviour during production and/or processing.

4 Regulatory requirements and authorisations

FBE coatings for use with drinking water must comply with the necessary national and international drinking water regulations in order to be authorised for use. To this end, strict requirements are set regarding the hygiene and toxicity characteristics of the raw materials used. In Germany, the regulations governing this are the "Guideline for the hygienic assessment of organic coatings in contact with drinking water", abbreviated to "Coating guidelines", which contain the so-called "positive list". Only those source materials included in the positive list and positively categorised by the EFSA (European Food Safety Authority) or the "Consumer Goods Commission" of the BfR (Federal Institute for Risk Assessment) may be placed on the market. Tests are carried out in different temperature ranges.

Microbiological safety according to DVGW work sheet W 270 [1] is to be achieved. The material releases issued by the authorities are checked for current validity in regular audit monitoring sessions and updated if necessary. Resicoat® has numerous hygiene certificates for use with drinking water, meaning that the material can be employed across the world: UBA/KTW (D), WRAS certificate (UK), ACS (F), KIWA (NL), Belgaqua (B), NSF61 (US), AS/NZS4020 (Australia) and so on.

5 Surface preparation

No coating is of better quality and more durable than the underlying quality of its surface preparation allows. In multiple-jet wheel blasting units the cast iron or steel products are cleaned from oxidation products or other impurities which stimulate corrosion.

Soluble salt compounds must be almost completely removed in order to effectively prevent potential osmosis phenomena (blistering after diffusion = delamination) when in operation.

Energy-intensive, mechanical blasting using hard, sharp-edged chilled cast iron grit **(Figure 1)** profiles and roughens the metal surface. This increases film adhesion significantly and hence the protective effect of the FBE applied. Isolated casting spikes can be eliminated during the blasting process, whereby the number of holidays, or discontinuities in the coating can be reduced or completely avoided. By contrast, sharp-edges are not significantly rounded by blasting and so edges with radiuses suitable for coating must be taken into account in the pattern. The quality of the blasting process and of the blasting agent used in the system must be monitored and documented on an ongoing basis.

Figure 1:
Outwardly recognisable difference of sharp-edged original blasting agent (left) as compared with the "rounded" blasting agent used (right)

6 The application of FBE

The prepared casting is heated to approx. 200 °C surface temperature and integrally coated – i.e. a seamless single coat is applied all round – using the manual electrostatic spraying process or a fully automated fluidised bed process. The specified minimum coating thicknesses are usually in the range 250 µm to 400 µm. In individual cases, thicker coatings of up to 600 µm/800 µm are required (sewerage or seawater applications, desalination plants), which are also applied in a single operation **(Figures 2 and 3)**.

Figure 2:
Manual coating process using an electrostatic gun – the powder is melted directly on the hot substrate resulting in the continuous build-up of a film
Source: Düker GmbH

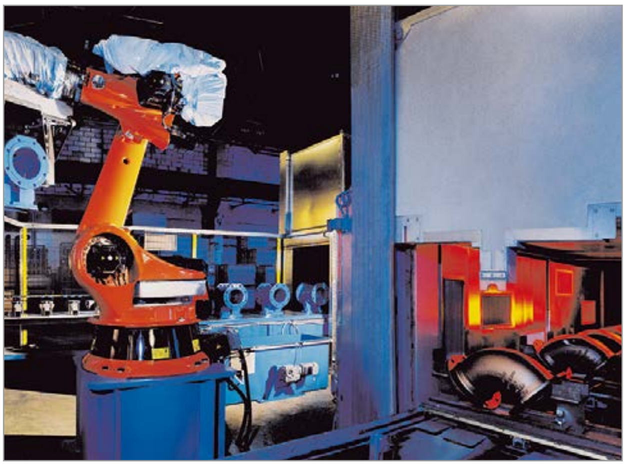

Figure 3:
Automatic fluidised bed using robots which move on multiple axes – the film is built up in seconds during the brief time of contact between hot item and powder
Source: Keulahütte GmbH

The complete curing of the epoxy film is done by the transfer of heat from the casting to the thermo-reactive organic plastic film. Separate post-curing of the component is only necessary in exceptional cases, in so far as the stored heat is not sufficient for "self-curing": this can be the case with thin-walled objects, with very large nominal sizes and long coating times (a higher level of heat loss during the application process) or for a case where a specific, more inert FBE powder is being processed which has been used in order to achieve the highest possible surface smoothness.

7 The corrosion protection effect of FBE

The reliable corrosion protection effect of thick-film FBE results from the interaction of its adhesiveness to the substrate and freedom of porosity. With a dielectric strength of an intact film of approximately 7,500 V/250 µm, corrosive attack by ubiquitous electrolytes is prevented to the best extent possible. Salt spray resistance levels of 4,000 hrs to ISO 9227 [2], [3] can be achieved without serious underrusting at the point of cutting damage. The permeation rates of low molecular, and hence diffusion-active substances specific for FBE, such as water ($3.9\text{-}6.1 \times 10^{-6}$ g cm^{-1} h^{-1} bar^{-1}), underpin the particular material suitability in permanent contact with drinking water or other aqueous media of different compositions.

8 Evaluating the protective effect of FBE

In contrast to "active corrosion protection" (cathodic protection), with "passive corrosion protection" the FBE coating takes on the function of inhibiting or delaying oxidation:

The natural oxidation process of iron

$$Fe \rightleftharpoons Fe^{++} \rightleftharpoons Fe(OH)_2$$
(anodic equilibrium reaction)

is opposed by the reduction of water to hydrogen:

$$2\,H_2O \rightleftharpoons 2\,OH^- + 2\,H^+ \rightleftharpoons H_2$$
(simplified representation of the cathodic equilibrium reaction)

Thus, in addition to raising the local pH value (OH^-) the cathodic partial reaction leads to the formation of hydrogen gas H_2. Both phenomena represent a direct attack on the coating and more specifically on an existing point of damage in the coating.

The purpose of measurement and assessment of the cathodic disbondment resistance, which is an element of numerous test specifications, is to quantify the protective function of FBE coatings applied. The CD test simulates the delamination behaviour at a defined, artificially produced holiday running through to the bare metal substrate, which is triggered either by a cathodic protective current or by hydrogen generation in aqueous sodium chloride solution. The specimen undergoes cathodic polarisation in this process, in that it is connected to an adjustable power source at the negative terminal. Usually the anode consists of a platinum electrode or platinised titanium wire. Testing times and temperatures are variable, often over a period of 30 days at room temperature (23°C) **(Figure 4)**.

For the purpose of the highest possible repeatability of the test results, measurement is done with the aid of an additional potentiostat which keeps the natural electrochemical voltage difference between the coating specimen to be tested and a reference electrode – either mercury/mercury chloride (calomel) or silver/silver chloride – constant. No current flows through the reference electrode here **(Figure 5)**.

In the area of defects, or their immediate environment, electrolytically produced hydrogen attacks the FBE coating at the phase boundary to the metallic substrate. Specific spots with insufficient adhesion (impurities, air inclusions, pores) fill up with H_2 gas which, under continuous pressure increase, can lead to blistering of the coating **(Figure 6)**.

Therefore, both the water vapour permeability of the FBE itself and the number and size of possible coating defects (caused during the pre-treatment and application process) influence the extent of hydrogen generation and thus directly influence the efficacy, i.e. the corrosion protection effect, of the FBE.

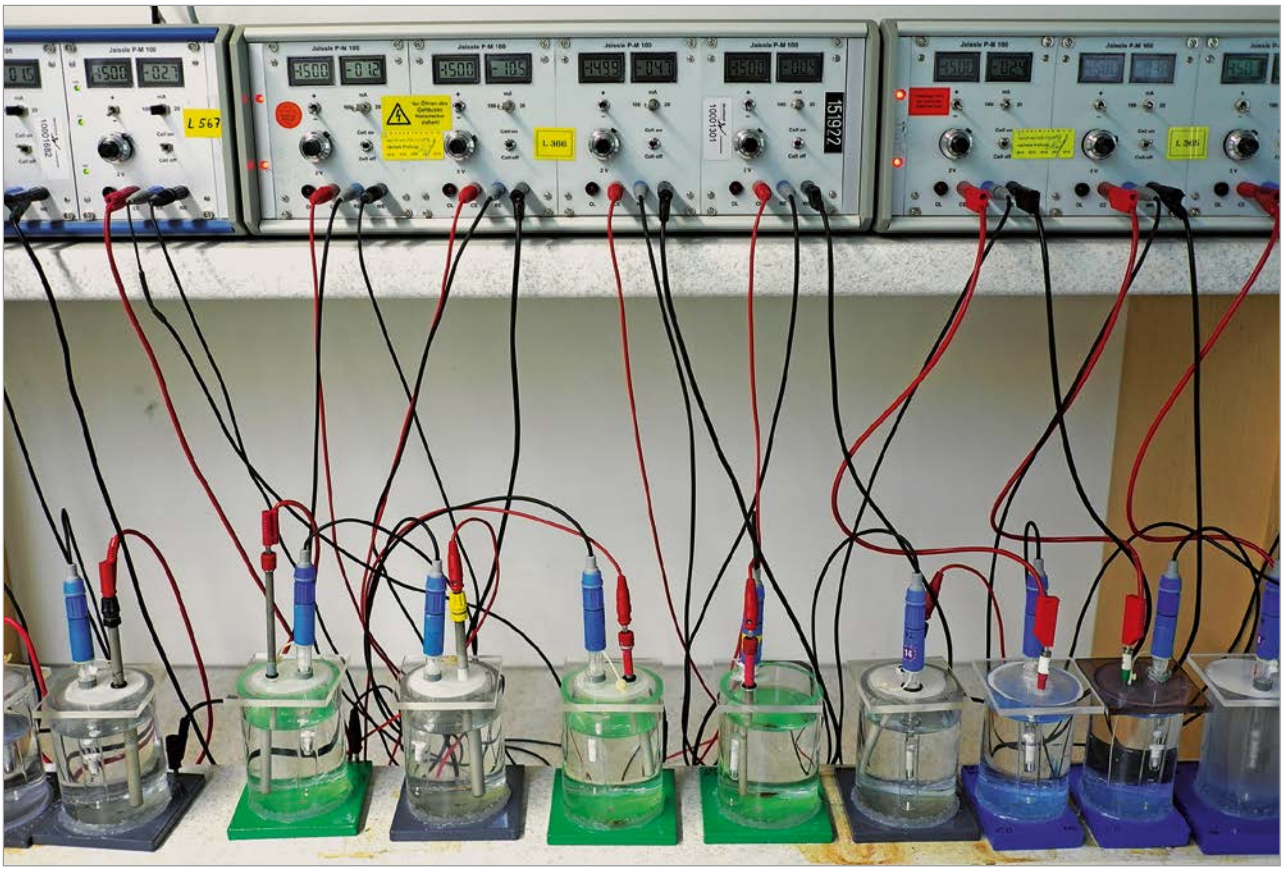

Figure 4:
Test assembly for the cathodic disbondment test with potentiostat, electrodes, specimens – the reference potential $U_{calomel\ saturated}$ is set to –1,500 mV

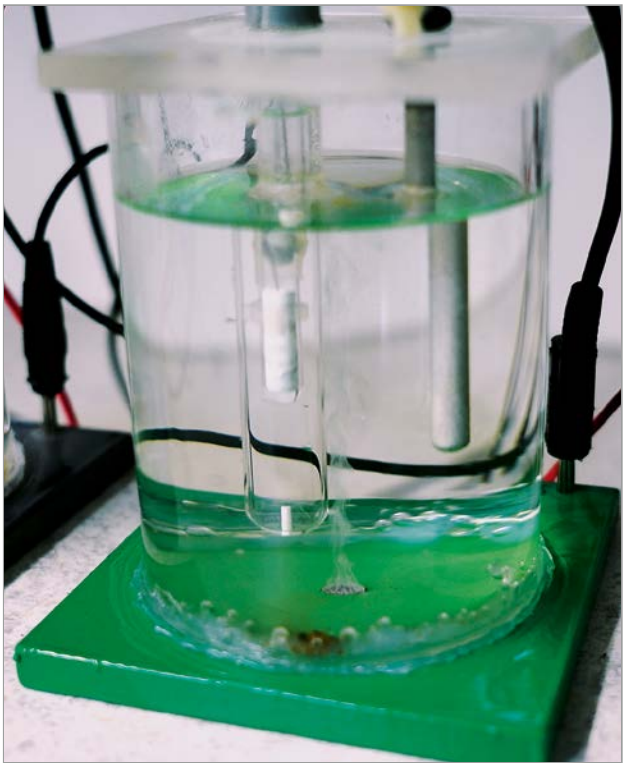

Figure 5:
Coated specimen during the measuring process – calomel reference electrode (left), platinum electrode (right), hydrogen development is visible at the point of the defect

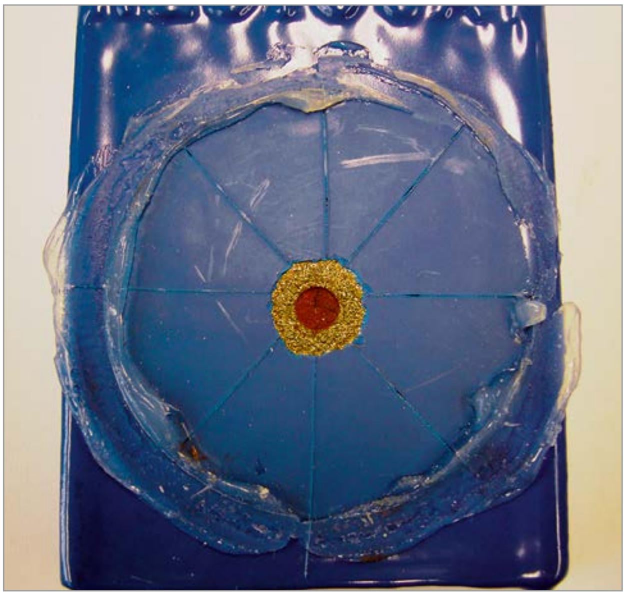

Figure 6:
The disbondment area – from the outside edge of the artificially created defect to the integrity of the original film adhesion

This applies to intact coatings and even more to damaged ones (transport, installation, operation etc.). Hence the CD test is an effective method for the continuous quality control of the coating process:

- blasting quality, in other words the purity and profile of the metal surface,
- the temperature of the workpiece during application,
- the quality of the FBE used,
- coating thickness,
- the degree of cross-linking of the coating film

all have a direct effect on long-term corrosion protection behaviour.

9 Outlook

For many years, coating specifications for the protection of offshore pipelines have been showing a trend towards increased minimum coating thicknesses in order to exploit the potential of the high passive corrosion protection effect of FBE more effectively. Something similar is also conceivable in the area of application of cast iron valves and fittings installed underground and above ground, but the value mentioned at the start of around 600 µm represents a limit which, wherever possible, should not be exceeded for technical reasons, so that complete cross-linking from the stored heat of components is reliably maintained and the ductility of the film is retained.

Bibliography

[1] DVGW work sheet W 270: 2007-11
[2] EN ISO 9227: 2012
[3] prEN ISO 9227: 2016

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The state capital of Saxony-Anhalt puts its trust in valves and fittings in ductile cast iron with epoxy powder coating

By Sigmund Pionty and René Pehlke

1 The state capital Magdeburg

Magdeburg, as the capital of the state of Saxony-Anhalt, lies at the point where the Elbe and the Elbe-Havel and Mittelland canals intersect. With 235,723 inhabitants, it is one of the largest cities in Germany as well as being a university city; the landmark of Magdeburg is its cathedral. Famous sons of the city are Otto von Guericke who, with his experiments with the Magdeburger hemispheres, became one of the originators of vacuum technology, and the Baroque composer Georg Philipp Telemann.

The utility company Städtischen Werke Magdeburg GmbH & Co. KG (SWM Magdeburg) **(Figure 1)** is responsible for the supply of drinking water, gas, power and district heating to the population and also for sewage disposal in the city of Magdeburg, as well as managing the operations of the water supply association in the district of Schönebeck.

SWM Magdeburg

Figure 1:
Logo of Städtische Werke Magdeburg GmbH & Co. KG

2 Städtische Werke Magdeburg GmbH & Co. KG

For the supply of drinking water, SWM Magdeburg maintains a total of approximately 1,224 km of pipeline systems, of which 818 km are main and supply pipelines with a proportion of some 360 km in cast iron. The Magdeburg drinking water is of a very high quality. It comes from the groundwater reserves of the Colbitz-Letzlinger moors, the largest uninhabited area in Germany. Even the ground water is of perfect bacteriological quality.

3 Construction projects of SWM Magdeburg

In 2016, extensive construction work was carried out in the area of the Wiener Straße in Magdeburg **(Figures 2 and 3)**. Among other things this involved the main supplies from the "Thauberg" elevated tank supplying the Sudenburg and City Centre areas of the city. In general, this supply serves to stabilise the water supply for the entire urban area of the City of Magdeburg. In the "Halberstädter Straße – Südring – Wiener Straße" area under improvement there are also connections to the main supply pipelines going in the direction of Stadtfeld and Leipziger Straße (district of "Reform"). Another important reason for the renovation of the drinking water pipeline is the extension of the "Halberstädter Straße – Südring" intersection to improve traffic conditions. The tram route is being extended here.

Figure 2:
DN 500 valves and fittings in ductile cast iron – Wiener Straße

Figure 3:
Valves and fittings in ductile cast iron in the DN 150 range – Wiener Straße

4 Installation of ductile cast iron fittings and valves

For the section of work described above, Keulahütte GmbH in Krauschwitz supplied pressure pipe fittings (DN 80 – DN 700, PN 10) to EN 545 [1] as well as double eccentric butterfly valves in DN 400 and DN 500, PN 10, to EN 593 [2], [3], soft-seated gate valves in DN 80 – DN 150, PN 10, to EN 1171 [4] and DN 80 underground hydrants (single shut-off device) to DIN 14339 [5] and DVGW test specification W 386 [6]. All pressure pipe fittings, valves and hydrants are given an integral epoxy powder coating according to GSK (Gütegemeinschaft Schwerer Korrosionsschutz) guidelines [7].

The no-compromise quality of Keulahütte GmbH – and this covers the complete and almost unique production cycle, beginning with the casting process and going on to processing and coating right through to assembling the valves at the Krauschwitz location, as well as open and close communication with the client – was the essential criterion for their selection in the highly competitive valves market.

5 Construction material

EN-GJS-400-15 (spheroidal graphite cast iron) was adopted as the construction material for the butterfly valves, gate valves and hydrants. Because of the optimum ratio between strength and elongation at break characteristics, this modern cast material is recommended for many types of use. The combination of a minimum elongation at break of 15 % with a tensile strength of at least 400 N/mm² is the basis of a safety strategy in which improper overloading makes itself known by visible plastic deformation long before fracture point is reached **(Table 1)**.

Table 1:
Mechanical characteristics and structural properties of the cast iron material for valves and hydrants

	Valves and hydrants	Fittings
Mechanical characteristic ($t \leq 30$ mm)	**EN-GJS-400-15 (EN 1563 [8], [9])**	**EN 545 [1]**
Tensile strength R_m (MPa) min.	400	420
Yield strength $R_{P0,2}$ (MPa) min.	250	270
Elongation at break A (%) min.	15	10

Structural properties	**EN-GJS-400-15 (EN 1563 [8], [9])**
Graphite structure (as per ISO 945-1 [10], [11])	Form V and VI
Dominant structure	Ferrite

6 Corrosion protection with epoxy powder coating

In the choice of corrosion protection, users are counting more and more on epoxy powder coating. Constant process and material development has meant that this type of protection has long been used in pipeline construction. However, it is only with all-round coating of the valve components that its full potential can be put to optimum use with valves and hydrants.

In conjunction with the processing and quality parameters of the coating, this so-called "integral corrosion protection" meets some very high expectations in terms of useful life. An essential condition here is a nominal coat thickness of at least 250 µm; the requirements must be met without compromise. With the greatest of care, components are blasted on all sides in a forced-flow process, cleaned, heated and then coated without any time delay.

This is an absolute precondition for the desired properties of epoxy powder coating:

- outstanding adhesive strength of min. 12 N/mm² (after 7 days in hot water),
- absence of pores under 3 KV high voltage testing,
- cathodic disbondment < 10 mm (CD test),
- impact strength > 5 Joules,
- complete cross-linking (MIBK test),
- high abrasion resistance,
- temperature resistance with respect to liquid media up to 40 °C/50 °C (long-term use),
- extremely high resistance to chemicals while being suitable for drinking water,
- professional repair sets allow points of damage to be repaired with the same type of material.

In the area of main and supply pipelines, the piping network of Städtische Werke Magdeburg GmbH & Co. KG has a high proportion of cast iron pipes. Cast iron is a well-tested material which, even in the past, proved its reliability and resilience. With a body of scientific knowledge which has been built up over decades, modern ductile cast iron, now as ever, defends its position for use in buried pressure pipelines and plant construction. Right from the point of selecting material in the planning phase, its outstanding properties offer a strong argument, especially under constantly increasing traffic loads. In combination with modern epoxy power coating – as long as the parameters stated above are respected – the positive quality features are enhanced and the long working life of the pipeline network is therefore established.

Bibliography

[1] EN 545: 2010
[2] EN 593: 2009+A1:2011
[3] prEN 593: 2016
[4] EN 1171: 2015
[5] DIN 14339: 2005
[6] DVGW test specification W 386: 2014-09
[7] RAL – GZ 662: 2014-08
[8] EN 1563: 2011
[9] prEN 1563: 2016
[10] EN ISO 945-1: 2008+AC:2010
[11] prEN ISO 945-1: 2016

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The new generation of resilient seated gate valves

By Matthias Müller

1 Presentation

The latest TALIS innovation: a resilient seated gate valve under the name INFINITY is the new generation of this series **(Figures 1 and 2)**. Available in nominal sizes DN 40 to DN 600 and in pressure ratings PN 10 and PN 16, this valve corresponds to the latest state of the art with some unique properties.

Figure 1:
Sectional view of an assembled INFINITY gate valve in nominal sizes up to DN 300

Figure 2:
Sectional view – the design of an assembled INFINITY gate valve in nominal sizes DN 350 to DN 600

All parts of the INFINITY resilient seated gate valve are produced in European countries **(Figures 3 and 4)**. The use of high quality materials, processed using the latest production technologies, guarantees that the operator gets a valve with a long working life, with very good operability and with unparalleled safety features.

Figure 3:
Individual parts of the INFINITY up to nominal size DN 300

2 The construction of the INFINITY

The new wedge guide system between valve body and wedge and the new stem bearing with a one-piece stem **(Figure 5)** reduce friction forces and ensure functionality with low torque values.

The stem bearing for nominal sizes DN > 300 has a deep groove ball bearing both above and below the stem collar as standard which considerably reduce the torque. The bonnet with bayonet locking (up to DN 300) contains a threadless stem bearing, meaning that seamless coating is possible. The patented bayonet locking is fitted with a triple lock with anti-twist protection. This makes self-dismantling impossible. The medium-free stem bearing with a number of O-rings can be considered to be "maintenance-free" and suitable for installation underground.

Figure 4:
Individual parts of the INFINITY in the DN 350 to DN 600 design

Figure 5:
One-piece stem with stem collar – rolled trapezoidal thread

Figure 6:
Dust cap with 3 seals

Figure 7:
Fully rubberised wedge in EPDM or NBR quality – Wedge guide with special plastic rails vulcanised on to it – stem nut loosely inserted

Therefore, the connection bolts between valve body and bonnet are countersunk and sealed. The threaded blind holes are reliably protected against corrosion by the gasket housed in a groove between bonnet and valve body.

With its three sealing lips, the dust cap on the bonnet keeps dust, dirt and moisture safely away **(Figure 6)**. This is an advantage with installation underground, in a drinking water treatment plant or in a shaft in which condensation water can occur.

The guide system for the wedge has been revised. The U-guide for the wedge in the previous version has now been transferred to the valve body. A C-guide has been mounted on both sides of the new wedge onto which a further C-shaped guide element in special plastic is pressed. The long wedge guide prevents the wedge from "tipping" under operating pressure, which in turn counteracts any misalignment of the stem nut, i.e. wear on the stem nut is reduced and pressure on the stem from the medium is relieved.

The plastic rails are vulcanised onto the fully rubberised wedge **(Figure 7)**. They stop the corrosion protection in the valve body guide being damaged and thus prevent friction damage and also help reduce operating forces. The newly designed wedge has a broad sealing profile which, regardless of the pressure of the medium on the wedge, means that reliable tightness is achieved.

After opening, the wedge is located completely outside the free passage. This means that the passage is now smooth and piggable, offering no obstacle to the medium, and so flow resistance is very low and the depositing of solid particles is avoided. Not least this also means that the equipment can be operated economically.

The stem nut is loosely inserted in the wedge housing; this means that, as compared with a stem nut which is permanently cast in the wedge housing, it can adapt itself better to any misalignments of the firmly fixed stem. This increases the service life of the stem nut considerably. Also, as an expendable part, it can be replaced without problem if necessary.

3 Corrosion protection

Two coating systems are available **(Figures 8 and 9)**. One is the tried and tested epoxy powder coating with a coating thickness of at least 250 µm in accordance with GSK guideline RAL – GZ 662 [1] with the DVGW drinking water KTW certificate and DVGW work sheet W 270 [2] and the other is the enamel corrosion protection system.

Both corrosion protection systems are seamlessly applied to the valve body parts (valve body and bonnet) both inside and outside.

Figure 8:
INFINITY without handwheel – short design R14 to EN 558 [3] with epoxy powder coating

Figure 9:
INFINITY in the long R15 construction – enamelled inside and out – with integral edge protection on the gasket seal

Having been fired at around 720 °C, enamel is a glasslike, high-strength material which, together with the metal support material (in this case cast iron with spheroidal graphite EN-JS 1050 to EN 1563 [4], [5]), coalesces into a permanent and inextricable bond, where no separation of the protective coating is possible at points of damage. A special fibre material is embedded in the enamel. In the event of damage, these fibres prevent any rupture of the enamel. The surface of the enamelling is extremely smooth, which is a basic condition for perfect hygiene conditions. It does not embrittle, nor does it become chalky under UV light. Also, it is extremely resistant, both against high temperatures and against abrupt temperature fluctuations. This coating system is particularly suitable for hard (calcareous) water. It also has DVGW certification in accordance with [2]. The fully enamelled version of INFINITY has a gasket seal on the body/bonnet edge **(Figure 9)** with integrated edge protection to prevent impact damage during delivery and assembly.

4 Testing and certification

INFINITY has been designed with respect to standard EN 1171 [6]. The valve has been tested according to the criteria of EN 12266-1 [7], leakage rate A, and EN 1074-2 [8]. INFINITY possesses the DVGW test certificate for drinking water as well as ACS, WRAS and GOST certificates.

Material standards for drinking water applications:

- valve body parts in ductile cast iron EN-JS 1050,
- stem nut in brass 2.0202, UBA approved,
- EPDM seals and wedge rubberisation,
- stem in stainless Cr steel 1.4021,
- bearing bush in aluminium bronze,
- bolts in V2A,
- epoxy powder coating to GSK guidelines or
- enamel,
- application to max. 50 °C.

For use in the wastewater sector, other materials will be used according to the medium.

Figure 10:
INFINITY – design up to DN 300 in the long R15 construction – equipped with an adaptor for underground installation according to [10]

Figure 12:
INFINITY with electric drive attached, in the versions up to DN 300

Figure 11:
INFINITY up to DN 300 in the long R15 construction with handwheel and epoxy powder coating

5 Introduction onto the market

INFINITY will be introduced onto the German market in the middle of 2017 by ERHARD GmbH & Co. KG. The product range initially includes construction lengths R14 and R15 as per EN 558 [3] with the usual flange design to EN 1092-2 [9] in pressure ratings PN 10 and PN 16. Drive options available are the square-ended stem (for construction length R15 up to DN 300 produced for underground fittings **(Figure 10)** as per DVGW test specification GW 336-2 [10]), a design with a handwheel **(Figure 11)** and a design produced for or fitted with electric drive **(Figure 12)**. The resilient seated INFINITY gate valve can be used for drinking water, industrial water, extinguishing water and wastewater.

Bibliography

[1[RAL – GZ 662: 2014-08
[2] DVGW work sheet W 270: 2011-07
[3] EN 558: 2008+A1:2011
[4] EN 1563: 2011
[5] prEN 1563: 2016
[6] EN 1171: 2015
[7] EN 12266-1: 2012
[8] EN 1074-2: 1074-2:2000 + A1:2004
[9] EN 1092-2: 1997
[10] DVGW test specification GW 336-2: 2010-09

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Construction of a new UV disinfection unit at the Wasserwerke Westfalen GmbH waterworks in Menden-Halingen

By Dietmar Hölting

1 Drinking water requirements

In order to be able to continue meeting the increasing requirements for drinking water (key term: "trace substances") in the future, by conveying and treating drinking water of the best quality, the Wasserwerke Westfalen GmbH (WWW) waterworks is gradually equipping itself with more advanced treatment facilities. This measure is particularly significant when seen against the background of a future revision of the Drinking Water Ordinance (TrinkwV) with new or tougher limits and action requirements.

As a rule, in this context the process of chemical disinfection using ClO_2 is switched over to physical disinfection by ultraviolet light radiation (UV disinfection).

2 Construction work

Therefore, before the construction of a new, progressive treatment plant, the precaution will also be taken at the Halingen waterworks of constructing and commissioning a UV disinfection plant.

Based on the consistently positive experiences with the reconstruction of the Echthausen waterworks in Wickede/Ruhr, the colleagues at WWW commissioned the GELSENWASSER Operations Division in Unna for the pipeline construction work necessary for this.

3 Constructional requirements

The concrete details of the assignment included:

- the installation of two DN 1000 butterfly valves as cut-out points between radiated and non-radiated drinking water in a double DN 1000 line,
- the construction of two DN 800 branches in the direction of flow before the separation flaps, each designed to be closed off separately using two DN 800 butterfly valves,
- the construction of two DN 800 branches in the direction of flow behind the separation flaps, each designed to be closed off separately using two DN 800 butterfly valves,
- the installation of the feed line to the UV disinfection plant in DN 800,
- the installation of the discharge line from the UV disinfection plant going towards the piping network in DN 800.

4 Performance of the work

All shutoff valves were selected and installed in the long construction form with a lateral bypass **(Figure 1)**.

The installation location of the valves and piping posed particular demands in terms of corrosion protection since shingle from the Ruhr exclusively had to be reused as the backfill material. Because of the changing groundwater levels close to the banks of the Ruhr with the backfill material being washed around by the water, backfilling the excavation areas with sand or stone-free soil was considered unsuitable. The corresponding experience was available.

Figure 1:
DN 800 feed and discharge line with enamelled DN 800 butterfly valves in ductile cast iron for the UV plant at the WWW waterworks in Halingen

Figure 2:
Detailed view of an enamelled DN 800 butterfly valve with lateral bypass and dismantling joint for the UV plant at the WWW waterworks in Halingen

5 Corrosion protection requirements

Because of good experiences in the past, trust was put in the enamel reinforced external enamelling product from Düker GmbH **(Figure 2)**. For many years now, GELSENWASSER has been working with the development and processing of technical enamels as corrosion protection. According to the company's own installation guidelines, enamelled fittings and valves can be installed in stone-free soils or sand without additional passive corrosion protection. But because of the particular situation at the Halingen waterworks and the importance of the valves in the network, in this case it was decided to use bitumen as additional corrosion protection, as well as rock protection mats for the mechanical protection of the valves.

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Our drive for innovation is optimisation

By Ursula Ritter

1 History

Double eccentric, resilient-seated Düker type 451 butterfly valves with slider crank gear have successfully been in worldwide use for decades. With their ductile cast iron body material, enamelled as standard to protect them against corrosion, they perform their tasks consistently and reliably in the widest range of applications and operating conditions.

And yet – as the saying goes: NOTHING is so good that it cannot be improved in the small details.

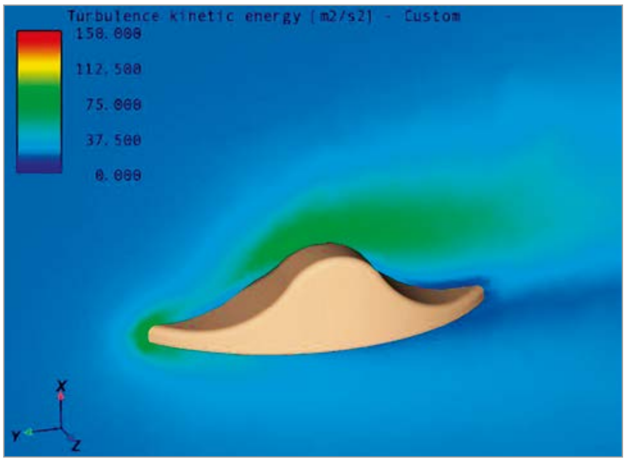

Figure 1:
Valve disc optimised with the help of CFD flow simulation

2 The NEW line

Düker type 4510 butterfly valves – seamlessly enamelled all round with Düker etec enamel, the trademark for the particular surface protection – meet the specific requirements of the modern water industry for economic efficiency, sustainability and long-term security to the highest degree.

Düker butterfly valves with their double eccentric valve disc design are leakproof in both directions of flow. The gearing layout is variable and can be selected according to the installation situation.

2.1 Valve disc

The favourable flow characteristics of the new valve disc have been optimised by CFD computer-aided flow simulation **(Figure 1)**. The new body shape of the disc combines the greatest stability and lowest pressure losses with outstanding cavitation protection.

The valve disc is completely enamelled and self-centring **(Figure 2)**. The main seal, an endless sealing ring with a pronounced O-ring profile, is attached via a one-piece clamping ring to the

Figure 2:
Fully enamelled self-centring valve disc

valve disc with bolts and fixed with threaded pins. By means of the fixing bolts, the main seal is easy to adjust and can be replaced without problem if necessary. With this system, a controlled prestress of the seal is achieved according to requirements. Even with high gap speeds there is no danger that the seal will be pulled out.

2.2 The connection between valve disc and shaft

A square plug-in connection **(Figure 3)** excludes play and guarantees optimum torque transmission. This construction makes it possible to keep the eyes of the valve disc closed with a blind hole. By means of an addition axial sealing element – an O-ring package between the bearing eye of the valve disc and the front face of the bearing bushing plus an additional O-ring arranged radially to the outside diameter of the bearing bush – a completely tight separation of the bearing from the medium is achieved. The formation of corrosion at connection points is excluded.

2.3 Bearings

Bearing bushes in special bronze mean excellent running properties under difficult conditions. They are highly wear resistant and offer an outstanding performance in terms of surface pressure and friction coefficient. Drive shaft and bearing journals in high-grade steel are enclosed by O-rings in a medium-free area between the bearing eye of the disc and the bearing bush **(Figure 4)**.

3 Slider crank gear

The self-locking slider crank gear developed by Düker GmbH has been used as standard and without compromise since the beginning of the production of the valve **(Figure 5)**. Robust, powerful and reliable for easy and secure operation with a differential pressure up to the level of the nominal pressure.

The principle of a slider crank gear is illustrated in **Figure 6**. According to Meyers Lexikon (Fig. 1, p. 855) a "crank gear (crank mechanism) is a mechanism which transforms a rotary motion into one going back and forth in a straight line or oscillating in an arc or, conversely, one of the latter motions into a rotating one. The most important crank gear is the slider crank gear".

Figure 3:
Square plug-in connection – connection between valve disc and shaft

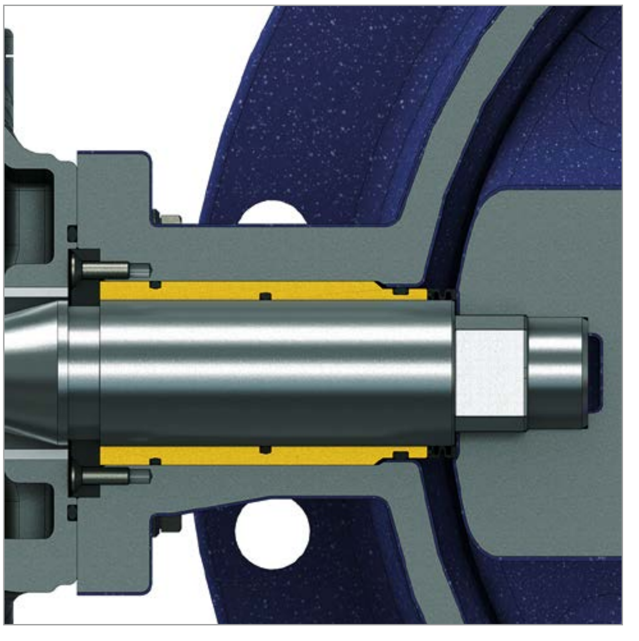

Figure 4:
Bearing bushes, drive shaft and bearing journals are fixed to the body to be secure from blow-out

Figure 5:
Self-locking Düker slider crank gear

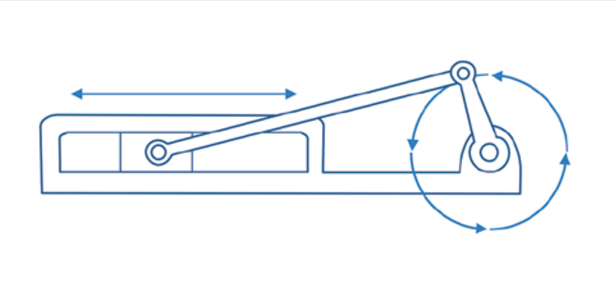

Figure 6:
Schematic representation of a slider crank gear
Source: Meyers Lexikon, Fig. 1, S. 855

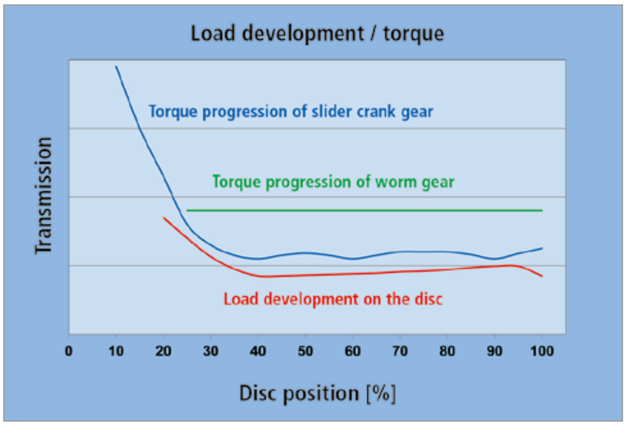

Figure 7:
Torque progression of a slider crank gear compared with a worm gear

The particular movement kinetics of the Düker slider crank gear is optimally matched to the torque requirement of the Düker butterfly valve. The torque progression required for operating the valve disc is not constant and linear as it is with worm gear drives, but climbs sharply shortly before the end point **(Figure 7)**. The open position area of the valve disk, which has no hydraulic effectiveness, is quickly passed. It is in the hydraulically effective end phase of closing that the closing speed becomes a very great deal slower.

This kinetic behaviour (knee lever effect) allows an extremely soft closure of the valve disc to be achieved, which ultimately means that the danger of pressure surges is minimised.

The advantages of a slider crank gear:

- a solid, closed cast iron housing to protection class IP 68, maintenance-free, outstandingly suitable for installation underground and use under water,
- adjustable limit stops on the stem, meaning that one limit stop ensures that no forces act on parts of the housing during operation,
- mechanical position indicators installed under synthetic glass as standard for optical control of the valve disc position,
- locking pins on the connecting flange between housing and transmission as an anti-rotation device,
- only one mounting flange (F10) needed for various drive options,
- handwheel with ball handle,
- installation kit with bell flange and O-ring for tight closure,
- electric drives – swivel drives – pneumatic drives – hydraulic drives – limit switches.

4 The range

4.1 Standard Düker butterfly valve

The standard Düker butterfly valve, face-to-face length F14 **(Figure 8)**, is available in nominal sizes DN 100 to DN 1200 and pressure ratings PN 10 – PN 25 plus PN 40 on request.

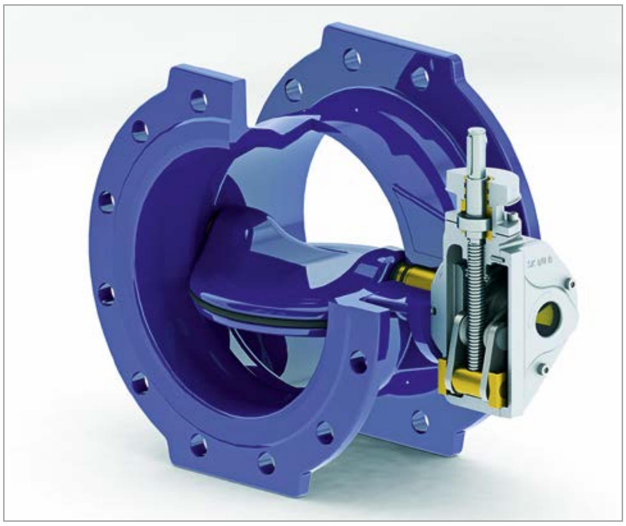

Figure 8:
Standard butterfly valve, face-to-face length F14

Standard coating:

- for the water industry: inside and outside with etec enamel in blue, special colours outside on request,
- for the gas industry: inside with etec blue enamel, outside in yellow enamel or inside with etec blue enamel, outside with PUR, 15 KV tested.

In addition to the standard design, there is also a series of designs for special uses.

4.2 Long-design butterfly valves

Düker butterfly valves in the long R15 version with bypass **(Figure 9)** are available in nominal sizes DN 300 to DN 1200 and pressure ratings PN 10, PN 16 plus PN 25 on request.

Area of use and options:

- for filling and draining pipelines without pressure surge via the butterfly valve installed in the bypass, avoiding costly assembly in the pipe trench,
- bypass 1/10 of nominal size DN – other diameters possible,
- without bypass.

Figure 9: Butterfly valve long design R15 with bypass

4.3 Butterfly valve with block flange

Butterfly valves with block flanges **(Figure 10)** are suitable for venting before and after the valve body seat. Example: hydrants or gate valves with aeration and vent valves.

Figure 10: Butterfly valve with block flange

4.4 UVV butterfly valve with 3-point locking

UVV butterfly valves with 3-point locking **(Figure 11)** are designed to be able to be inspected in accessible pipeline systems. The details: two fixed stops and one movable stop. With the movable stop, manipulating the handwheel causes a bolt to slide into the valve body and block the closed valve disc. The two fixed stops are permanently fixed in the valve body. Additional mechanical locking of the bolt is available as an option, as well as position monitoring via limit switches.

Figure 11: UVV butterfly valve with 3-point locking

4.5 Butterfly valve with locking device

A butterfly valve with a locking device or flange on the blind side is shown in **Figure 12**. The locking device ensures that the valve disc is securely locked in the OPEN or CLOSED position. This means that gear replacement is possible during operation.

4.6 Butterfly valve with Novo Sit® push-in socket

The Düker butterfly valve with Novo Sit® push-in socket **(Figure 13)** is intended for restrained joint installation. It is available for ductile iron pipes in nominal sizes DN 150 to DN 500 and pressure ratings to PN 25. For PE pipelines, there is the butterfly valve with a weld-on PE transition piece in pressure ratings PN 10 and PN 16.

4.7 Butterfly valve with loose flange

A butterfly valve with a loose flange is pictured in **Figure 14**. One side has a restrained loose flange and the other side has a fixed flange. The

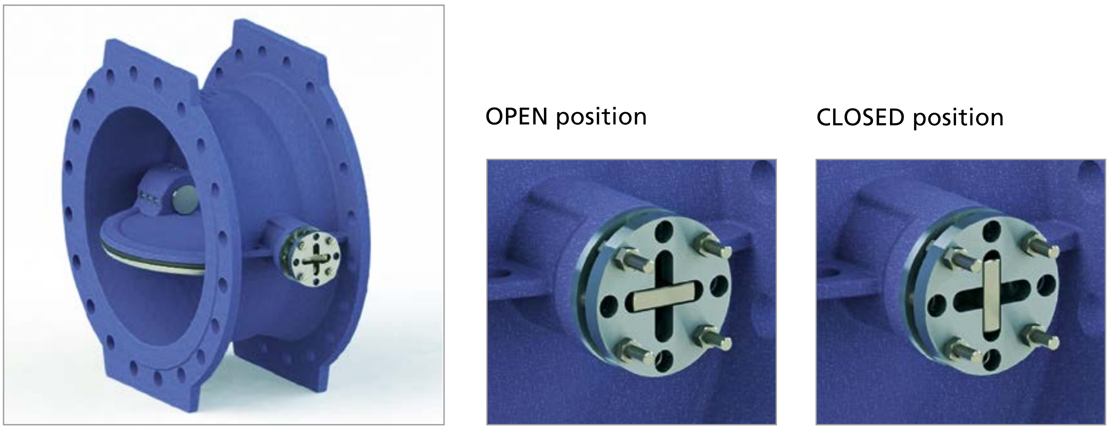

Figure 12:
Butterfly valve with locking device – OPEN and CLOSED valve position of the locking flange

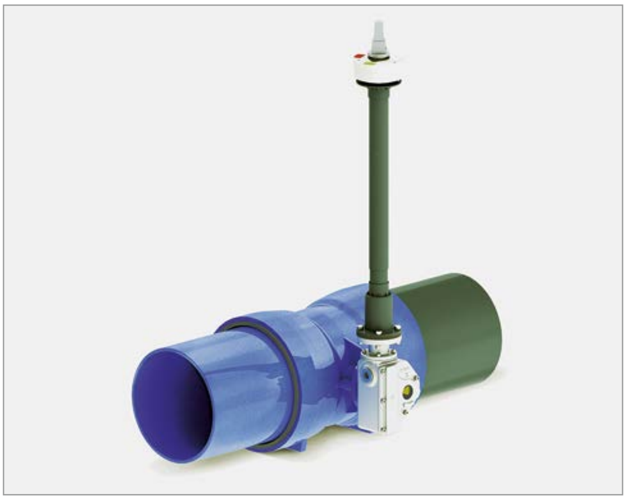

Figure 13:
Butterfly valve with Novo Sit® push-in socket

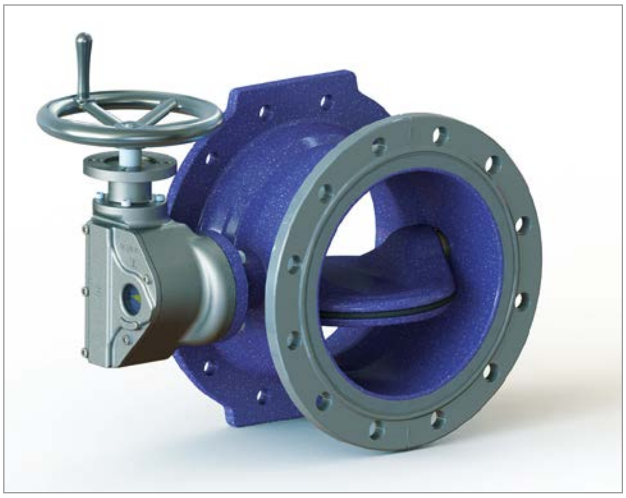

Figure 14:
Butterfly valve with a loose flange

butterfly valve with loose flange is used in piping networks and equipment and as a replacement fitting for renovation purposes (variable face-to-face length). With new equipment, there is no need for disassembling devices. The fixed flange guarantees a twist-proof installation.

5 Concluding thoughts

The robust and stable construction of Düker butterfly valves in combination with the outstanding material properties of the enamelling meet operators' high demands for quality, security, hygiene and a long working life without compromise. From production, through to operation.

Düker – Made in Germany

Our strength lies in our concentration on system technology, flexibility, durability and also on developing and maintaining the range of products. The focus is on innovation and customer benefits. Our challenge is to give the customer something which he really wants. The portfolio of the Düker family of butterfly valves has been redefined on the basis of this challenge.

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Elastomer seals in potable water applications

By Rüdiger Werner and Harald Hager

1 Introduction

The requirements for sealing materials in contact with drinking water are becoming increasingly strict and hence more complex. European countries have different requirements for the quality of drinking water and each has its individual national regulations for implementing the EU directive establishing standards for drinking water [1] (e.g. in Germany the drinking water ordinance TrinkwV 2001). The German Environment Agency (UBA) issues guidelines for assessing organic materials in contact with drinking water with respect to hygiene in the form of various guidelines. Woco has developed elastomer materials which unreservedly meet the German Environment Agency's guidelines for elastomers dated 22.12.2011.

Pipes and pipe joints for drinking water supply and installation are to be planned for a 50-year working life in accordance with standards EN 805 [2] and EN 806-2 [3], taking account of correct maintenance and appropriate operating conditions.

With pipelines for transporting water, the problem here lay in the tight and durable connection of the system components one to the other. The sealing problem has been solved by the use of seals in different elastomers. The demands on the sealing material are very high. The elastomer must meet legal, hygiene-related and technical requirements.

2 Requirements placed on elastomers for use in drinking water applications

The elastomer guidelines [4] published for the first time in 2011 by the German Environment Agency (UBA) state that the raw materials used for the production of elastomers must be assessed according to the principles of the European Food Safety Authority (EFSA). These are applicable for the approval of raw materials for the production of plastics in contact with foodstuffs.

The elastomer guidelines of 22.12.2011 replace KTW-Recommendation Part 1.3.13 (KTW = plastics in drinking water), the validity of which expired on 31.12.2016. The positive list in the elastomer guidelines comprises two parts. Part 1 contains all the raw materials tested by the UBA and evaluated as being harmless. Part 2 of the positive list covers those raw materials which have not yet been fully evaluated by the UBA. The substances in Part 2 could be used for a limited time until 31.12.2016.

At the moment, there are only a few formulations which meet the requirements of Part 1 of the positive list. To date the UBA has only received a few applications for transferring raw materials in elastomer formulations from Part 2 to Part 1 of the positive list. Therefore, after listening to the manufacturers' associations concerned, the Environment Agency has extended the deadline for the transitional arrangement for the use of substances from Part 2 of the positive list. This should avoid a situation where, as from 01.01.2017, there are no elastomers available on the basis of the positive list dated 22.12.2011.

Woco IPS – Pipe System Components – has developed some special elastomer materials which already meet the requirements of the Environment Agency's elastomer guidelines (i.e. in accordance with Part 1 of the positive list) for hygienic safety and enhancement of microbial growth without reservation. Woco offers the various materials (EPDM, butyl, etc.) to the user in hardness grades of 55-85 Shore A for pipeline seals and sealing systems.

The requirements for finished sealing systems are specified in the relevant product standards. According to these, the performance of a pipeline joint seal depends on the material properties of the seal, the geometric shape of the gasket and the construction of the pipe joint.

European standard EN 681-1 [5], [6] sets the material requirements for pipeline joint seals (vulcanised rubber seals) for applications in the water supply and drainage sector. Pipes and fittings in ductile cast iron and their joints for pipelines transporting water are produced in accordance with EN 545 [7]. The construction details and material parameters of gaskets for TYTON® and STANDARD push-in joints are defined in DIN 28603 [8].

In addition to this, there is DVGW test specification W 384 dated May 2014 [9], produced by the DVGW in the Technical Committee on "Water supply system components", which has replaced the old VP 546:2007-05. It determines requirements and tests for sealing systems for push-in joints in ductile cast iron or steel pipelines. It also contains information on quality assurance for these components, which should ensure that the components produced are in conformity with the requirements of these test specifications, even in the long term. Components which meet these test specifications are also in conformity with the applicable European standards, the requirements of the DVGW rulebook and national legal provisions. By means of self-monitoring plus the external monitoring prescribed annually, the manufacturer is ensuring the necessary reliability, serviceability, quality, hygiene and environmental compatibility as required for use in the drinking water supply sector. Evidence of this – and a criterion for clients – is e.g. a DVGW type examination certificate **(Figure 1)**.


DVGW CERT

DVGW-Baumusterprüfzertifikat
DVGW type examination certificate

DW-5114BQ0382
Registriernummer
registration number

Anwendungsbereich *field of application*	Produkte der Wasserversorgung *products of water supply*
Zertifikatinhaber *owner of certificate*	WOCO IPS GmbH Hanauer Landstraße 16, D-63628 Bad Soden-Salmünster
Vertreiber *distributor*	WOCO IPS GmbH Hanauer Landstraße 16, D-63628 Bad Soden-Salmünster
Produktart *product category*	Schmier-/Dicht-/Betriebsmittel: Dichtung für Muffenverbindungen in Rohrleitungen (5114)
Produktbezeichnung *product description*	Gummidichtungen für Muffenverbindungen in Rohrleitungen aus duktilem Gusseisen
Modell *model*	Tyton

Figure 1:
An extract from the DVGW type examination certificate for Woco IPS GmbH

3 Measuring the compression set

An important criterion for a reliable statement on the durable tightness of a pipe joint is the compression set. The compression set provides information on the viscoelastic properties of a sealing material. The compression set is measured in accordance with test specification ISO 815-1 [10] or ISO 815-2 [11] as follows **(Figure 2)**:

- production of cylindrical samples and measurement of the original height H_0,
- deformation on H_1 (25 % of H_0) for a given time,
- measurement of thickness H_2 after release,
- achievement of compression set according to Equation 1.

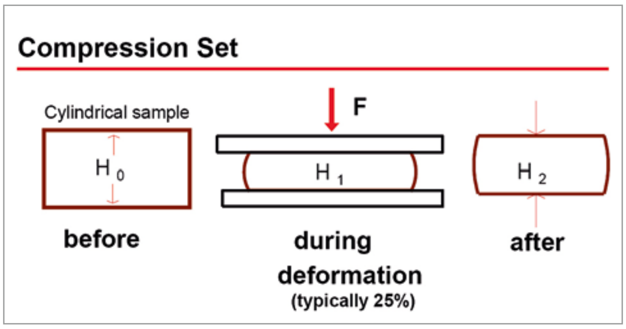

Figure 2:
An illustration of compression set measurement as per ISO 815-1 [10] or ISO 815-2 [11]

$$\text{Compression Set} = \frac{H_0 - H_2}{H_0 - H_1} \times 100\ [\%] \quad (1)$$

Example:
On a DN 200 TYTON® gasket with a sealing bead diameter of c = 18 mm **(Figure 3)**, a compression set of 8 % means a parameter of 0.36 mm ($H_0 - H_2$) and a compression set of 12 % means a parameter of 0.54 mm ($H_0 - H_2$).

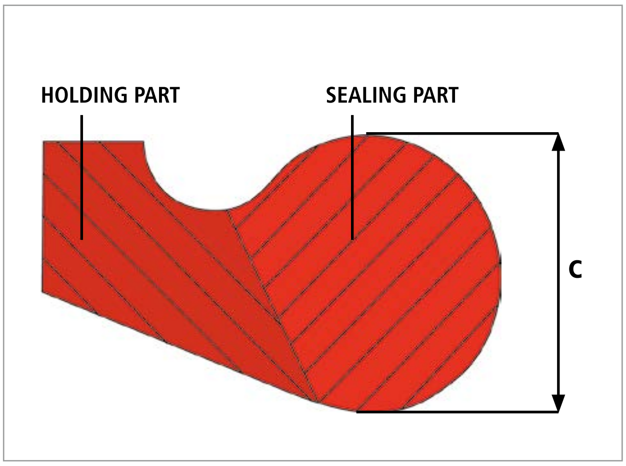

Figure 3:
Cross-section of the TYTON® gasket

The TYTON® gasket **(Figure 3)** consists of a combination of two different hardness grades with one soft part (sealing part) at 55 Shore A, which ensures the sealing function, and one hard part (holding part) at 85 Shore A, which fulfils the holding function during assembly. For the soft part, according to EN 681-1 [5], a max. compression set of 12 % after 72 hrs at 23 °C applies. However, Woco bases itself on the higher requirement of DIN 28603 [8] of 8 % for hardness class 50 and thus places its products as well as the products of its client at a higher quality level.

4 Performance of long-term tests

In the context of predicting the long-term behaviour of sealing systems, for a long time Woco has been working with validated calculation methods. To this end, a test method had previously been developed in a research project with DVGW to enable a prediction to be made over a period of at least 50 years. The basis of the test was determining the compression set on O-rings in diverse elastomer types over one year with temperature and time as the variables.

In this way, it was able to be shown that analysis using a calculation process according to Arrhenius supplies good results. The working life of a component was calculated by means of linear damage accumulation. This process used real time-temperature collectives actually measured. In order to check the results, the data determined experimentally were run through a reaction kinetics computer simulation. These calculations produced almost identical results. Meanwhile this method has been included and implemented in DVGW test specification G 5406 [12].

Basically, the method is also suitable for elastomer seals in water applications and is therefore also used for TYTON® gaskets in order to perform comparative measurements on competitive parts or to obtain computational deductions of long-term behaviour.

The following example **(Figure 4)** shows the course of the long-term compression set at 23 °C according to the method in DVGW test specification G 5406 [12] calculated for TYTON® EPDM (ethylene-propylene-dien-ter-polymer) 55 Shore A gaskets (standard specimen, 25 % deformation). The first compression set value in **Table 1** after 72 hrs was 8 %. After 50 years, it is around 40 %, which is to be classified as very good. For comparison purposes: normally limit compression set values of at least 70 % and worse are calculated!

Table 1:
Compression set calculation values according to Arrhenius

Time		Compression set (%)
Hours	Years	Calculated value
71.4	0.008	6.5
247	0.028	8.0
903	0.1	10.0
8,232	0.94	15.0
33,946	3.9	20.0
90,621	10.3	25.0
183,741	21.0	30.0
308,137	35.2	35.0
449,718	51.3	40.0

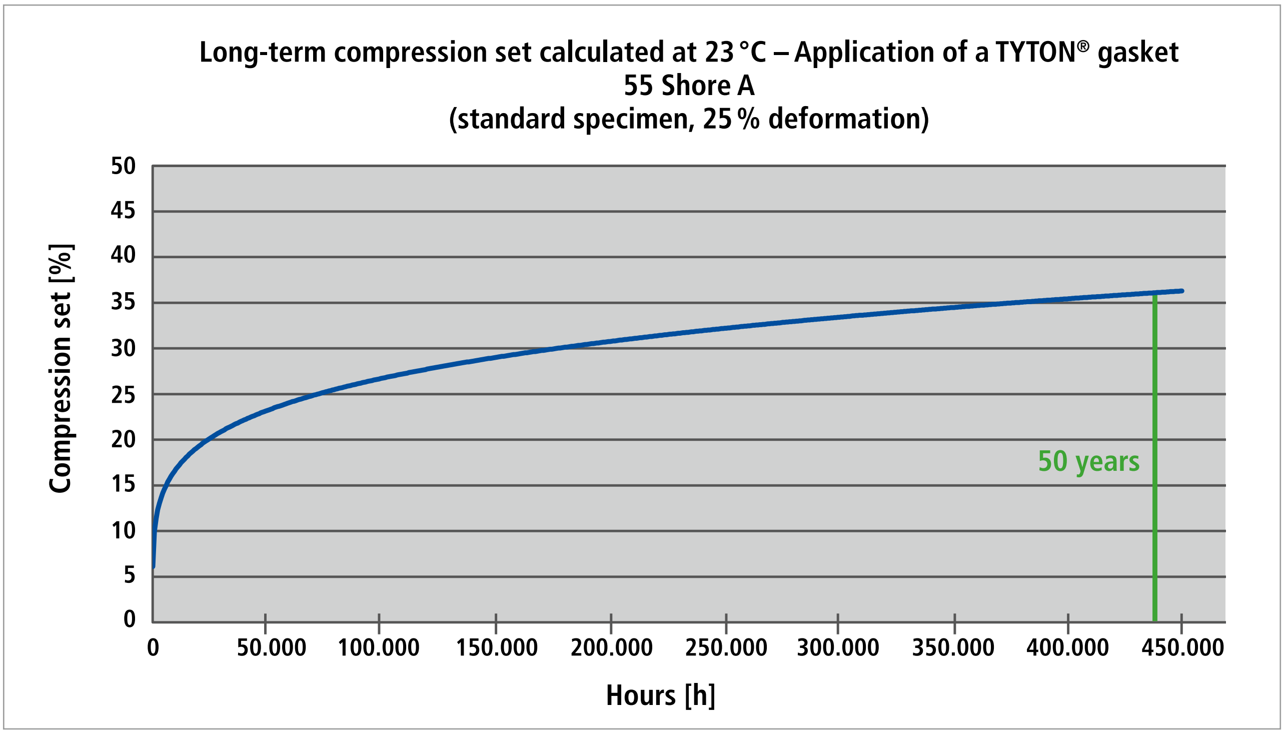

Figure 4:
Long-term compression set calculated according to [12] for a TYTON® gasket, EPDM 55 Shore A at 23 °C

5 Conclusion

Sealing systems in elastomer materials have been used for more than 50 years in drinking water applications and have proved excellent in practice. Long-term trials and compression set testing provide very good evidence of this finding. Despite new directives and guidelines, we are in a position to offer high-performance materials for water supply both now and in the future.

The Woco IPS GmbH Pipe System Components (PSC) business unit is a specialist in the worldwide market of sealing elements for pipeline systems and supplies materials and products which fully comply with the positive list Part 1 of the UBA elastomer guidelines and which are suitable for a wide range of applications.

Bibliography

[1] EU Directive 98/83/ EU dated 3 November 1998 (EU OJ no. L 330 p. 32)
[2] EN 805: 2000
[3] EN 806-2: 2005
[4] Guidelines for assessing the hygiene of elastomers in contact with drinking water (Elastomer guidelines): 2011-12
[5] EN 681-1: 1996 + A1:1998 + A2:2002 + AC:2002 + A3:2005
[6] prEN 681-1: 2016
[7] EN 545: 2010
[8] DIN 28603: 2002-05
[9] DVGW test specification W 384: 2014-05
[10] ISO 815-1: 2014
[11] ISO 815-2: 2014
[12] DVGW Test Regulations G5406:2016-09

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Bypass Biel – ductile cast iron extinguishing water pipes in the Büttenberg and Längholz motorway tunnel

By Roger Saner

1 The City of Biel – the Swiss watch metropolis

In the Seeland region of the Canton of Bern, on the eastern shore of Lake Biel, lies the City of Biel, the tenth largest city in Switzerland with a population of just 55,000. Approximately 150,000 people live in the entire catchment area of the city. Directly on the so-called "Röstigraben", the boundary between the German and French speaking parts of Switzerland, Biel is the largest dual-language speaking city in the country. In addition, Biel is known as the watch metropolis and is the home of world-famous Swiss watchmakers.

2 The major Biel bypass project

The A5 motorway bypass around the City of Biel on the stretch between Solothurn and Neuenburg closes one of the last gaps in the Swiss national roads network. The new section also links the A5 and A16 Trans-Jura motorways and the T6 going towards Bern, which were built decades ago running from three directions to the outskirts of Biel. At the same time, regional traffic is to be concentrated and routed largely underground across the conurbation. Therefore, this project means that in future large parts of the region as a whole as well as the City of Biel will be relieved of through-traffic. The Canton of Bern is in charge of the A5 Biel bypass and responsible for the construction of the new motorway on behalf of the Federal Government.

After a construction time of just about 10 years, in 2017 the East branch in the direction of Bern will be opened. The East branch of the Biel A5, mainly running underground, runs from the present Biel East junction in Bözingenfeld, first of all through the Büttenberg tunnel. In the area of the district of Orpund the new motorway runs in the open for a short stretch and then goes into the Längholz tunnel **(Figure 1)** as far as the Brüggmoos junction.

Figure 1:
A view of the portal area of the Längholz tunnel

The construction of the West branch of the A5 Biel going towards Neuenburg is expected to begin in 2020; it should go into operation as from 2030. From the Brüggmoos junction the West branch of the A5 Biel in the direction of Neuenburg there will be the new bypass as far as the junction to the Vingelz tunnel and the existing A5 motorway **(Figure 2)**.

3 Extinguishing water pipelines in the Büttenberg and Längholz tunnels

The extinguishing water pipelines in these two tunnels have been produced with ductile iron pipes of the vonRoll DUCPUR type with push-in joints. The standard DUCPUR pipes have a zinc/bitumen coating to EN 545 [1] and a polyurethane lining (PUR) in accordance with EN 15655 [2].

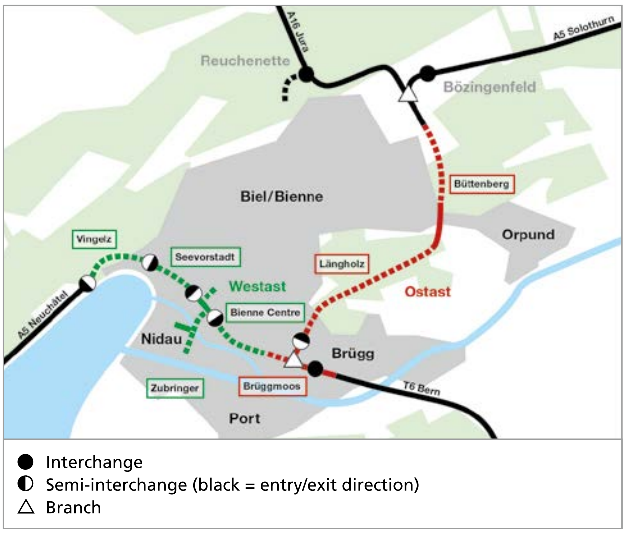

Figure 2:
A general view of the Biel motorway bypass
Source: (http://www.a5-biel-bienne.ch/de/kommunikation/medien-unterlagen/)

Figure 3:
A perspective of the Längholz road tunnel with lateral refuges/hydrant recesses

Figure 4:
Panoramic view of the extinguishing water pipeline in the service conduit with side branch and section shutoff valve

The glassy PUR lining prevents the build-up of deposits to a very high degree and, with minimum friction losses, enhances the hydraulic performance of the extinguishing water pipeline in case of fire. The system has been completed with ECOFIT push-in fittings in ductile cast iron with integral epoxy coating to EN 14901[3] and the enhanced requirements according to RAL – GZ 662 [4] and DIN 3476 [5].

In both tunnels, the extinguishing water pipelines are each arranged in a service duct underneath the carriageways, from where they run from lateral branch pipelines to the hydrant recesses in the directionally separated double-pipeline tunnel tubes **(Figures 3 and 4)**. Because the extinguishing water required comes from the drinking water supply network, excessive warming of the water in the extinguishing water pipeline in the service duct must be prevented. Therefore, the ductile iron pipes and fittings of the main DN 200 pipeline are additionally provided with external heat insulation **(Figure 5)**.

Figure 5:
DUCPUR heat-insulated ductile iron pipes in the service conduit

Figure 6:
Standard pipe clamp fixing of the insulated extinguishing water pipeline

Figure 7:
Post-insulation with shrink-on sleeves at the sockets of the push-in joints

The heat insulation is applied to the DUCPUR pipes in the factory. The DN 200 cast iron pipes are pushed concentrically into PE-HD casing pipes, d = 315 mm, and the space between them is filled with CFC-free rigid polyurethane foam. The spigot ends must remain free in each case for the assembly of the socket joints.

In the service tunnel the pipes were mounted on the concrete substrate (walls/floors) with standard pipe clamps. After assembly, the socket joints were post-insulated with shrink-on sleeves **(Figures 6 and 7)**.

All the joints of the flexible push-in system were secured with vonRoll HYDROTIGHT restrained thrust protection, Fig. 2807 B **(Figure 8)** and Fig. 2806 **(Figure 9)** to absorb the forces occurring at changes in direction or cross-section and at the point of fittings.

The installation of the branch pipelines to the hydrant recesses was facilitated by cladding tubes encased in concrete into which the DN 125 DUCPUR pipes were inserted on skids. The very tight space conditions set some major demands for the precision of the work in connection areas, especially as regards the flexibility of the HYDROTIGHT thrust resistance system **(Figure 10)**.

Figure 8:
Push-in joint with vonRoll HYDROTIGHT internal thrust protection Figure 2807 B

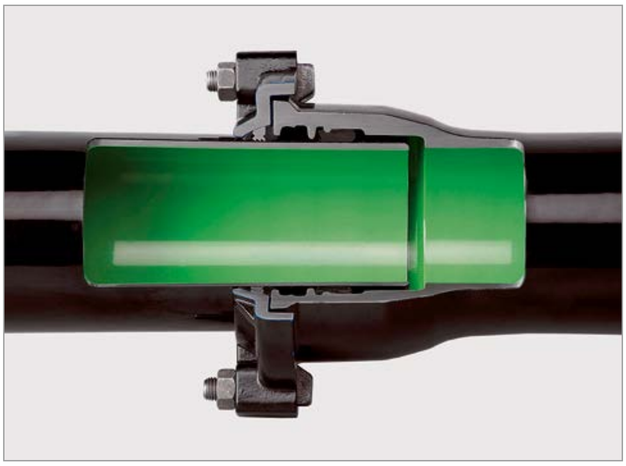

Figure 9:
Push-in joint with vonRoll HYDROTIGHT external thrust protection Figure 2806

Figure 10:
DN 125 branch pipeline to the hydrant recesses in the casing pipe (at the front in the picture) and flushing fitting with tapping saddle on the main pipeline (in the background)

All the challenges for an efficient and economic installation of the vonRoll iron pipe system in this area were able to be met without problem thanks to the easily aligned pipe joints using the external restraint system Fig. 2806 **(Figure 11)**.

In total, more than 8,000 m of DUCPUR DN 200 ductile iron pipes for the main pipeline and approximately 400 m of DUCPUR DN 125 for the branch pipelines to the hydrants were installed for the extinguishing water pipelines in the Büttenberg und Längholz road tunnels for the A5 Biel East branch project.

4 Innovative hydrants for extinguishing water supply

In the two tunnels of Büttenberg and Längholz, in the event of fire extinguishing water is supplied by means of more than 50 hydrants which are arranged in the tunnel tubes at regular intervals of approximately 150 m. They are installed in the hydrant recesses at the sides and connected up to the branch pipelines **(Figure 12)**.

In each case the hydrants consist of a vonRoll VARIO 2.0 underground section and a vonRoll HYTEC upper section.

Figure 11:
DN 125 branch pipeline, easily aligned fittings with external thrust protection Fig. 2806

Figure 12:
Hydrant recess with connection of the VARIO 2.0 hydrant lower part to the DN 125 branch pipeline

The height of the VARIO 2.0 lower hydrant part in ductile cast iron can be adjusted via a simple bayonet system in stages of 5 cm; it can be operated by one person alone. The clever construction of the VARIO 2.0 allows the smallest installation heights from 25 cm cover depth and opens up undreamt-of possibilities – especially in tunnel construction where the space conditions are often precarious **(Figure 13)**. Even with this minimum height, a double shutoff is available as standard, which enables inspection work to be carried out on the hydrant under full mains pressure. Subsequent replacement of the double shutoff itself is also possible without problem.

At the client's request the main valve can be selected with either radial or conical sealing and in fact can be converted later. All the cast iron components of the hydrant upper section – inlet elbow, casing and telescopic pipe and the counter flange – are fully coated with epoxy resin (EN 14901 [3] / RAL – GZ 662 [4]). All the components used are produced in stainless steel. The material combinations are perfectly matched and characterised by high wear resistance.

The HYTEC upper hydrant section has been developed for use in an aggressive tunnel environment. Its main parts are produced in a corrosion resistant aluminium alloy and individual components are also provided with a robust, weather-resistant Toplex coating. The HYTEC hydrant can be infinitely aligned in a full 360° circle and is therefore perfect suited to use in the narrow installation recesses in the new motorway tunnel. In addition, because of the high base ring, adjustment of the installation height by +/– 50 mm is possible **(Figure 14)**.

5 Full-protection shutoff valves for extinguishing water supply

Various shutoff valves of the vonRoll VS 5000 type were used for the extinguishing water pipeline in the motorway tunnel. This includes section valves, shutoff valves for the branch pipelines to the hydrants and tapping saddles for the cleaning nozzles and for drainage into the main pipeline in the service conduit **(Figure 15)**.

The corrosion protection concept for the VS 5000 full-protection shutoff valve has been rigorously applied at vonRoll. The full-protection philosophy for maximum long-term security includes:

- integral epoxy coating to EN 14901 [3]/ RAL – GZ 662 [4],
- boltless connection between the upper and lower parts of the housing,
- continuously coated coarse thread **(Figure 16)**.

Figure 13:
Tight space conditions for installing the hydrants

Figure 14:
vonRoll VARIO 2.0 hydrant lower section and vonRoll HYTEC hydrant upper section after final assembly

Figure 15:
vonRoll valves in use – section valves, shutoff valves for branch pipelines and a tapping saddle for drainage

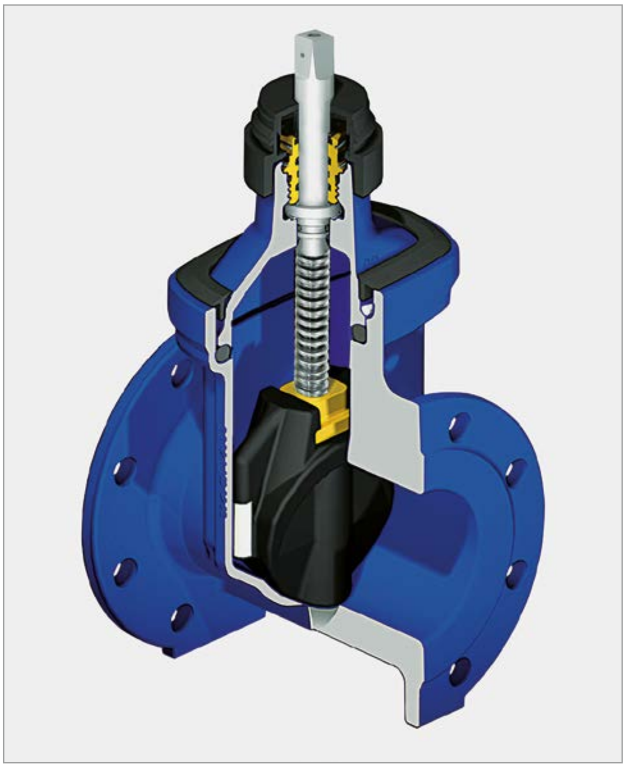

Figure 16:
Cross-section of the VS 5000 full-protection valve with boltless connection and coated coarse thread

6 Conclusion

In motorway tunnels, especially, very high requirements are set for tunnel safety by the operators right from the planning stage and these must be implemented with absolute top priority. In order to give a reliable guarantee of maximum volumes of extinguishing water in the event of fire, ductile iron pipes are the optimum solution for extinguishing water pipelines in tunnel constructions in every case.

Flexible cast iron pipe systems with restrained push-in joints can be perfectly adapted to the circumstances inside the tunnel during installation. The lining with polyurethane (PUR) offers a very high hydraulic capacity for the extinguishing water pipeline thanks to its hydraulically smooth surface. Together with the outstanding flow rates of the hydrants and shutoff valves, these pipelines offer high operational security for the supply of extinguishing water in demanding tunnel structures.

Bibliography

[1] EN 545: 2010
[2] EN 15655: 2009
[3] EN 14901: 2014
[4] RAL – GZ 662: 2014-8
[5] DIN 3476: 1996-08

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Pipeline construction

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Bergbahnen Westendorf – snow-making is faster with ductile iron pipes

By Mario Ruggenthaler

1 Ski circuit in the Kitzbühel Alps

The famous "SkiWelt Wilder Kaiser – Brixental" ski circuit, along with the local community of Westendorf (Brixental in Tirol) and Westendorf Mountain Railways in the middle of the Kitzbühel Alps, is once again increasing the output of its snow-making equipment, which has already been greatly extended. With the increased water storage facilities, in future it will be possible to cover the entire skiing area with a solid base of snow within 72 hours. In order to be able to supply the snow guns with an increased throughput, around 7,800 m of new pressure pipes in ductile cast iron have been installed. Among other things, this means snow cover for an additional 8.4 ha of piste surface.

2 Current and future snow-making equipment

At the moment, the major part of the water needed is taken directly from the Windauer Ache mountain stream. Additionally, the equipment includes a storage reservoir and four pumping stations without any storage which, along with two pressure reducing stations and two compressor stations, ensure that the system is operable. The aim of the extension is to enable the entire area to be provided with snow cover within 72 hours using stored water, whereby the efficiency of the equipment will be considerably increased. To this end, the existing 65,000 m³ capacity "Kreuzjöchelsee" storage reservoir will be enlarged to 190,000 m³.

3 Increasing the annual consent

Currently 97.6 ha of piste surfaces are supplied with snow, requiring an annual consent of 317,000 m³ (corresponding to roughly 3,250 m³/ha). The snow surface of a total of 106 ha, enlarged by 8.4 ha, increases the annual consent required to 345,000 m³. The specific water consumption of about 1,700 m³/ha for the ground coverage will be made available from the storage reservoir once the project has been completed. A rapid topping up of the reservoir is ensured via the existing piping system.

4 Installation of additional pipelines

The required snow-making capacity will be supplied by two to three fan snow guns per hectare and, for the 1,700 m³/ha to be transported in 72 hours, this means a throughput capacity of just about 8 l/s per hectare of snow surface. Because the storage reservoir is located on the eastern edge of the area, a supply pipeline from the "Kreuzjöchelsee" lake to the mountain station of the Alpenrosenbahn is necessary. It will be about 2,500 m long in nominal size DN 500 (last DN 400) and will supply the entire upper ski area.

A number of pipelines **(Figure 1)** run from the extraction structure in the bed of the reservoir under the dam through to the pumping station **(Table 1)**.

The seepage water from the drainage system at the foot of the dam and land drainage systems beneath the sealing sheet of the reservoir are collected in the pumping station **(Figure 2)** and fed back into the lake by a submersible pump. In case of damage, an integral DN 250 discharge pipeline housed in the pumping pit drains into the stilling basin before the pumping station. The high-water outlet, with a DN 600 pipeline and its own discharge structure, is located on the western embankment.

Figure 1:
Ductile iron pipelines – five DN 80 reservoir pipelines and two DN 600 extraction pipelines

Figure 3:
Field pipeline installation – DN 500 transport pipeline

Table 1:
Summary of ductile iron pipelines running from the extraction structure to the pumping station

Type	Nominal size	Pressure rating
Extraction pipeline 1	DN 600	PN 10
Extraction pipeline 2 (also emergency draining)	DN 600	PN 10
Reservoir circulation	3 x DN 80	PN 10
Reservoir temperature	DN 80	PN 10
Reservoir level	DN 80	PN 10

Figure 2:
Construction of the new pumping station

Table 2:
Summary of nominal sizes DN, allowable operating pressures PFA and installed pipeline lengths with ductile iron pipes

Nominal size	Allowable operating pressure PFA [bars]	Pipeline length [m]
DN 600	32	~ 240
DN 500	50	~ 2.060
DN 400	50	~ 460
DN 300	63	~ 1.120
DN 250	63	~ 1.660
DN 200	63	~ 1.150
DN 150	63	~ 500
DN 80	100	~ 675

In total, around 7.800 m of piping material has been installed, of which about 7,100 m are for the main field piping system **(Figure 3)** with branch pipelines with a length of some 700 m. A summary of the pipes with the well-proven BLS®/VRS®-T push-in joint can be seen in **Table 2**.

5 Description of the branch pipelines

All socket tees as branches from the main pipeline form the connection to the hydrants at the tapping points and connect up to DN 80 branch pipelines in underground shafts (concrete shafts). From these the pipeline is linked by snow hydrant bends (ENH bends) **(Figure 4)**.

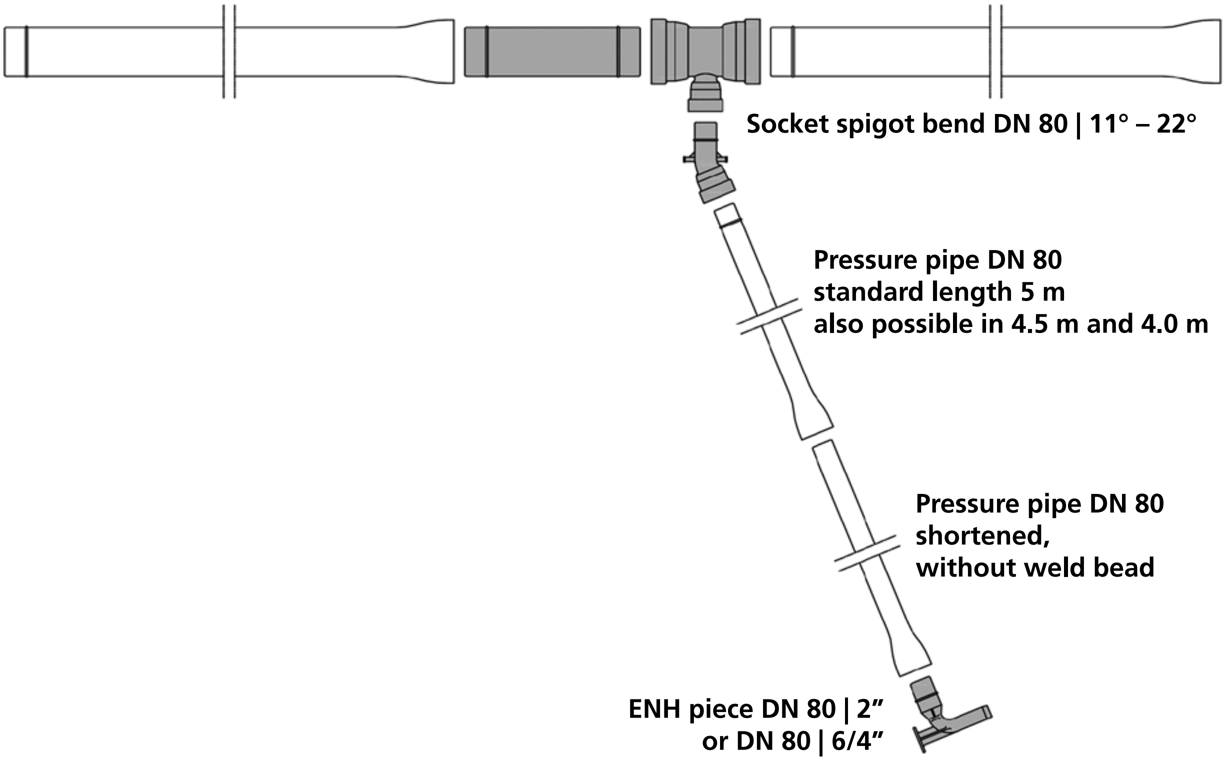

Figure 4:
Example of the design of branch pipelines with possibility of connection (ENH connector) to the snow guns

6 Requirements for ductile iron pipes

The large differences in height in the ski area place high requirements on the pipe material used. In addition to the hydrostatic pressure, it must also be able to absorb pressure surges. Pressure surges are unavoidable on account of control processes. Regulating devices with corresponding closure times and pumps with appropriate characteristics reduce pressure surges during control processes such as the closing of hydrants or the drop-out of pumps. In order to be able to withstand these extra requirements, ductile iron pipes have to be produced according to the minimum standard of EN 545 [1].

In Austria, there are also more far-reaching requirements in the relevant standards (e.g. ÖNORM B 2599-1 [2], ÖNORM B 2597 [3] and ÖNORM B 2560 [4]) to be observed. The pipes manufactured in this way are to be tested under the least favourable conditions required in these standards **(Table 3)**. Evidence of testing is to be submitted to the client on request. Under type testing, cast iron pipes from Tiroler Rohre GmbH (TRM) are tested under the least favourable conditions at 1.5-times PFA + 5 bars (worst-case testing). Furthermore, they have a threefold safety reserve against internal pressure.

TRM has a corresponding test bench on its factory premises and carries out all certification processes for all relevant nominal sizes there in collaboration with a state-accredited testing institute.

The pressure tests on site were conducted according to ÖNORM B 5050 [5].

Table 3:
Example of the requirements for type testing certification for ductile cast iron pipes with DN 250 VRS®-T push-in joints, allowable operating pressure PFA 100 bars (K 16)

Push-in joint	Test	Test pressure	Duration	Test conditions	=
VRS®-T push-in joint					
DN 250 K 16 PFA 100	Positive hydro-static internal pressure	155 bars	2 hrs	under shear load max. deflection largest annulus min. wall thickness	✓
	Negative internal pressure	– 0,9 bars	2 hrs	under shear load max. deflection largest annulus	✓
	Positive hydrostatic external pressure	2 bars	2 hrs	under shear load largest annulus	✓
	Cyclical hydrostatic internal pressure	Between PMA and (PMA-5) bars	24,000 pres-sure cycles	under shear load largest annulus	✓

Bibliography

[1] EN 545: 2010
[2] ÖNORM B 2599-1: 2016-08-15
[3] ÖNORM B 2597: 2004-10-01
[4] ÖNORM B 2560: 2014-12-01
[5] ÖNORM B 5050: 2015-11-01

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Hydropower plant Lago di Tomé – high pressure pipeline DN 400 for environmentally friendly electricity production

By Roger Saner

1 Introduction

The Alpine lake known as the Lago di Tomé lies in the municipality of Lavizzara in the Vallemaggia district of the Swiss Canton of Ticino **(Figure 1)**. The Tomé mountain stream flows from Lake Tomé into the valley of the same name and from there into the River Maggia, on the left bank just before the village of Broglio. The section between the Alpine lake, at the upper end of the valley at a height of 1,692 m above sea level, and the point where it joins the Maggia close to the village of Broglio, approximately 680 m above sea level, and hence with a geodetic head of more than 1,000 m, is of extreme interest in terms of using the water power for the production of electrical power.

The client for the construction and operation of the hydropower plant at Broglio is the newly founded joint stock company CEL Lavizzara SA.

Figure 1:
Lago di Tomé Alpine lake, 1,692 m above sea level

2 The project for a small hydropower plant

2.1 General design

The new Lago di Tomé hydropower plant consists of the following components:

- Water catchment and de-sanding basin,
- High-pressure underground pipeline,
- Power plant building,
- Tail race channel for returning the water.

2.2 Water catchment

The inlet structure has been built about 120 m beneath the outflow of the Lago di Tomé lake into the mountain stream and embedded in the stony topography of the river course. Clad in natural Ticino stone slabs, the inlet building blends into the environment. The water flows through a rectangular opening beneath the level of the water into the inlet structure, meaning that no flotsam can get into the de-sanding basin **(Figures 2 and 3)**.

2.3 New DN 400 high pressure pipeline

When selecting the appropriate material for the pressure pipeline, the clinching factors were on the one hand the tough installation conditions in the mountains and on the other hand the very high pressures of up to 100 bars with the almost

Figure 2:
Water supply into the inlet structure

Figure 3:
Inlet structure clad in natural Ticino stone

exactly 1,000 m height difference. What was needed was a flexible piping system which nevertheless had to offer outstanding mechanical and static strength characteristics.

Measured against these requirements, the tried-and-tested vonRoll ECOPUR ductile iron pipes with reinforced coating to EN 545 [1] are the optimum solution for the pressure pipeline because of their technical performance. With the innovative vonRoll PUR coating technology, ECOPUR pipes ensure a very high hydraulic effectiveness (PUR roughness: k ≤ 0.01 mm) **(Figure 4)** and, with the pore-free PUR coating, they provide perfect external protection in all soils. Because of the consistently rocky terrain, the robust ROCK protective cover was also used, which had already been applied to the cast iron pipes in the manufacturer's works.

Figure 4:
Glassy PUR lining, hydraulically smooth
with roughness k ≤ 0,01 mm

Figure 5:
Deflectible HYDROTIGHT push-in joint

The deflectible HYDROTIGHT push-in joint makes assembly in steep terrain rapid and safe **(Figure 5)**.

The vonRoll ECOFIT type fittings required have an epoxy coating to EN 14901 [2] with the enhanced requirements in accordance with RAL – GZ 662 [3]. The relatively low weight of vonRoll ECOPUR full-protection pipes was very helpful for the company constructing the pipeline in a steep and inaccessible environment because the pipes had to be transported by helicopter in order to be installed in the place of use **(Figure 6)**.

Over the entire 3,200 m length of the pipeline route, with a height difference of just about 1,000 m, there were various and challenging installation situations to be mastered in mountainous terrain with stony, rocky ground. In order to preserve the natural appearance of the environment as far as possible, the pressure pipeline was installed underground along almost its entire length, with one exception: the pipeline crosses a stream aboveground via a pipe bridge. The almost natural reconstruction of the route was done with excavation material and natural rocks and boulders **(Figures 7 and 8)**.

Depending on the elevation, the new pressure pipeline was designed for pressure ratings from PFA 10 bars to PFA 80 bars with ECOPUR pipes in various wall thickness classes from K 7 to K 15 with restrained push-in joints of the HYDROTIGHT type. In the upper area to PFA 16 bars, friction locking push-in joints push-in joints were sufficient to absorb the forces while also offering a large degree of flexibility with shortened pipes in the trench.

In the areas with higher pressures – up to PFA 80 bars in the lowest part of the pipeline – ECOPUR full-protection pipes were provided with welding beads in the factory and restrained with the HYDROTIGHT positive locking thrust protection system Fig. 2805 **(Figure 9)**.

With the steepness of the terrain and because of the high operating pressures, reinforced concrete thrust blocks were positioned at points of directional change to take up the forces occurring.

Instead of using shortened pipes processed on site, the manufacturer – vonRoll hydro (suisse) ag – supplied short pipes in precisely defined lengths with welding beads applied in the factory, which are fully protected with polyurethane. This made the expensive application of welding beads and subsequent repair of the external protection at the installation site unnecessary.

Figure 6:
Transport and installation of ECOPUR pipes by helicopter

Figure 7:
ECOPUR pressure pipeline above ground installed on rock

Figure 8:
Almost natural reconstruction with a quarry stone wall around the pressure pipeline

Figure 9:
ECOPUR full-protection pipes with ROCK protective cover and external HYRDOTIGHT thrust protection Fig. 2805

In the high pressure area, as from PFA 63 bars, standard push-in fittings in wall thickness class K 12 were no longer sufficient for absorbing the forces occurring. For this application, vonRoll hydro (suisse) ag produced special fittings in wall thickness classes K 14 and K 15.

At regular intervals, inspection openings were also arranged along the pressure pipeline. These are designed as DN 400/400 double socket tees with flanged branches, also in a special design up to K 15 and with flanges for the pressure ratings necessary in each case up to PN 63 **(Figure 10)**.

The lowest and steepest area of the pressure pipeline with the highest pressures – from 80 bars as far as the turbine house where it is almost 100 bars – was laid with welded steel pipes. For the transition area from ductile cast iron to steel, with PFA = 80 bars, once again a special fitting – flanged socket (E), with PN 100 bar flanges – was used **(Figure 11)**.

Figure 10:
Inspection and cleaning opening, DN 400/400 double socket tee with flanged branch, special design K 15 with flanges PN 63 bars

Figure 11:
Transition from ductile cast iron to steel, special fitting, flanged socket (E), with PN 100 bar flange

Parallel to the pressure pipeline, and in the same trench, empty pipes were also laid for the supply cable to the equipment at the water catchment area and also for the control cable for communication between inlet and power plant **(Figure 12)**.

Figure 12:
ECOPUR pressure pipeline with parallel-running empty pipes for supply and control cables

2.4 Power plant building and return channel

The location of the power plant building just before the point where the Tomé mountain stream flows into the Maggia is an optimum compromise between various influencing parameters. Among other things these include the geodetic height of fall and optimum access to the equipment during the construction work and for subsequent operation and maintenance with the least possible impact on the environment.

The power produced by the twin-jet Pelton turbine is fed into the 16 kV network of the Società Elettrica Sopracenerina SES. After going through the turbine, the water is returned to the Tomé mountain stream via a tailrace channel with a cross-sectional area of 1.5 m x 1.5 m and a length of 13 m and this stream later flows into the River Maggia **(Figure 13)**.

3 Some facts about the Lago di Tomé hydropower plant

- Water catchment area 3 km²
- Height of the Lago di Tomé Alpine lake 1,692 m above sea level,
- Water catchment capacity level 1,686 m above sea level,

Figure 13:
Power plant building with an underground channel to return the water to the Tomé mountain stream

- Power plant building, turbine shaft 704.55 m above sea level,
- Net head height 945 m,
- Average water volume supplied 3.10 million m³/year,
- Nominal size of pressure pipeline DN 400, effective length 3,110 m
- System output of power plant 2.05 MW,
- Net energy production 6.5 million kWh/year.

Bibliography

[1] EN 545: 2010
[2] EN 14901: 2014
[3] RAL – GZ 662: 2014-08

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Costeana small hydropower plant – ductile iron pipes solve the problem of landslip

By Luca Frasson

Figure 1:
Costeana small hydropower station

1 Introduction

Italy covers 20 % of its entire energy demand with environmentally friendly hydropower. However, the strict environment regulations for large hydroelectric power plants are a major obstacle here. For this reason, there are ever more small hydropower plants being built, which naturally offer particular challenges for technology and construction. And this was the case in Cortina d'Ampezzo where "Regole d'Ampezzo", a community participation association, arranged for an ambitious power plant to be built. The "Costeana" small hydropower plant **(Figure 1)** collects water from the river of the same name and, with two Pelton turbines, achieves an output of 4,5 GWh of green power in a normal year.

2 Planning

One particular challenge emerged during the planning stage. The only possible route lies on an unstable slope which is subject to a considerable amount of landslip when the snow thaws. Precise measurements were able to delineate the landslip area **(Figure 2, crosshatched area)** and showed that the slope moves almost vertically to the axis of the pipeline. An estimate of the amount of earth moved suggests a figure of 4 cm per month, or 50 cm over a year, under constant movement conditions. This meant that a solution using steel pipes alone was out of the question.

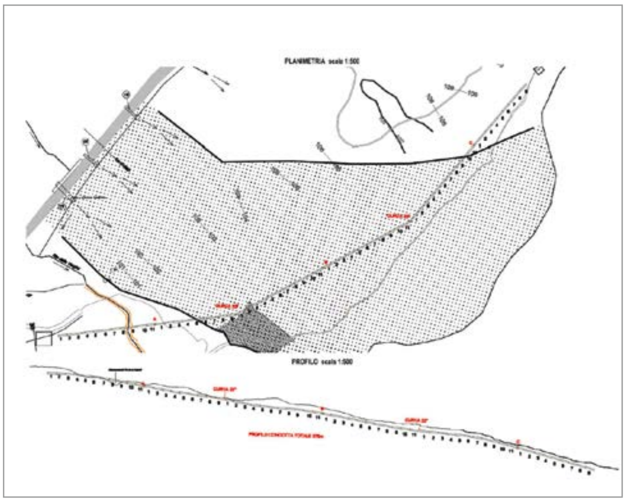

Figure 2:
Unstable slope, identified by crosshatching

3 Construction

Project manager Roland Bernardi and engineer Massimiliano Fellini, together with the team from Tiroler Rohre GmbH (TRM), developed an innovative solution for these challenging soil conditions. This consists of a combination of steel pressure pipelines above the particularly difficult area and ductile iron pipes with BLS® restrained push-in joints along the unstable slope. Ductile iron pipes with their flexible BLS® restrained push-in joint allow for dilation and angular deflection. Because of the different material properties of steel and cast iron, special transition couplings and concrete anchoring were necessary **(Figure 3)**.

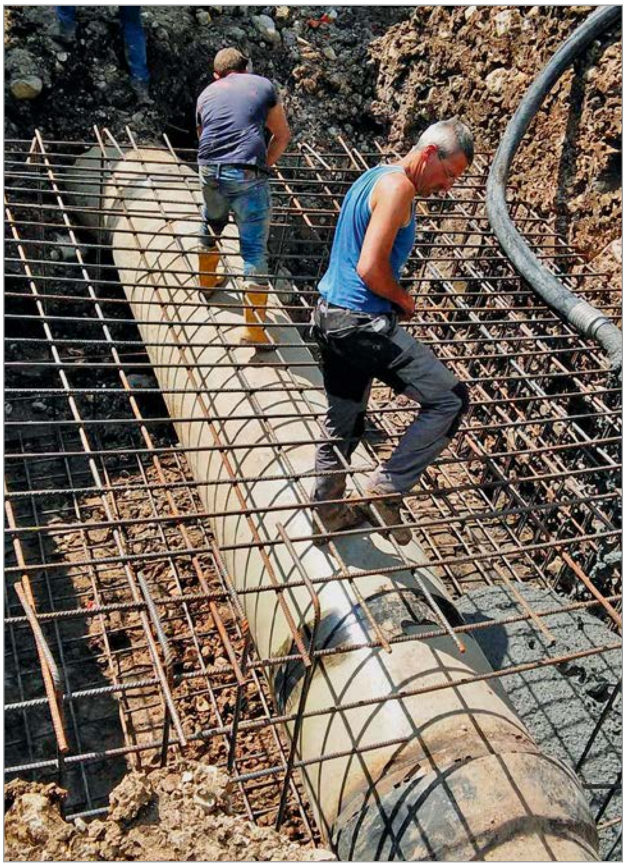

Figure 3:
Transition coupling between steel and ductile iron pipe

4 Installation of special fittings

Three equal pipe sections, each separated by two 22° bends, cover the 375 m long section of sliding slope. However, this decoupling alone did not entirely solve the problem of constant landslip. But a special product from TRM used in snowmaking technology offers the required flexibility: standard expansion compensation pieces can take up axial movements of up to 50 cm. For the power plant described, tailor-made fittings in steel were now developed which, at a length of 1.50 m, tolerate movement of up to 80 cm. Shafts for the expansion compensation pieces – in each case in the centre of the pipe section – make simple monitoring of the entire system possible by means of GPS sensors **(Figure 4)** or visual inspection in situ.

Figure 4:
GPS point

5 The function of the special fittings

In case of slope movement, the first tensile forces are taken up by the restrained push-in joints. As soon as the pipe connections are completely "drawn out", the expansion compensation pieces come into effect and offer an additional 80 cm scope for movement so that the natural contours of the terrain can be followed. This 80 cm room for movement is made possible by the combination of the BLS® push-in joint for securing one side of the expansion compensation piece and the TYTON® push-in joint on the other side, which allows the pipe plugged into it to slide freely **(Figure 5)**.

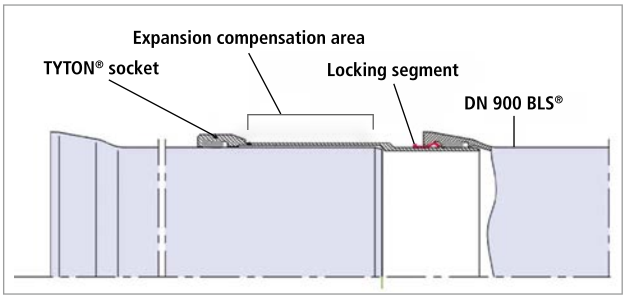

Figure 5:
Expansion comp

Figure 6:
Construction on the unstable slope

6 Installation of DN 900 ductile iron pipes

Good weather and the rapid and safe assembly of the BLS® push-in joints resulted in a site time of only two weeks for the installation of 375 m ductile iron pipes in DN 900 including expansion compensation pieces **(Figure 6)**. Because of the BLS® push-in joints there was no need for any welding work, test procedures, subsequent surface treatment or concrete thrust blocks. Furthermore, by using cement mortar coating for the ductile iron pipes, the high expense of exchanging the excavation material was saved. A further advantage of the cement mortar coating lies in its high load bearing capacity as well as the backfilling with a maximum grain size of 100 mm.

7 Outlook

Should the continuous movement of the slope calculated actually come about in its full extent, in the worst case a further section of pipe will have to be inserted after 20 years of operation in order to provide more room for movement. After one year of operation the system has already survived one melting of the snow without damage. This project shows the potential of ductile iron pipes in difficult terrain and provides some valuable knowledge and experience for future projects.

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Power plant pipeline for the Bristen power plant in the canton of Uri

By Werner Volkart

1 Planning and approval phase

In 2008 the planning phase commenced for the Bristen power plant in the Swiss canton of Uri. The planning and official negotiations dragged on for eight years. Eight years during which a detailed utilisation and implementation plan was drawn up for a hydropower plant. After all these efforts, the Bristen hydropower plant in the Maderaner valley is one of the most environmentally friendly ones in the whole of Europe. In March 2015, the time finally came: the positive report from the Swiss Nature and Homeland Security Commission (ENHK) was submitted in which it is unequivocally stated that the project at the Chärstelenbach meets the requirements for maximum possible environmental protection [1].

2 Choice of pipe material

Three months later the district of Silenen issued the construction permit. To be considered as the largest structural challenge, in addition to the completion of the water catchment, is the installation of the pressure pipeline in the upper section of the route as far as the catchment area, a difficult task in both topographical and geological terms. In total, the route of the pipeline extends over 1,800 m, for the main part through impassable terrain. For the pipe material, the operator opted for DN 1000 ductile iron pipes in the thrust and tractive restraint design. These were supplied by the Swiss pipe specialist TMH Hagenbucher AG from Zürich.

Ductile iron pipes are perfectly suited to these conditions. This is not merely to do with the high degree of resistance and the long working life of the pipes, but also their simplicity of installation: the trench is excavated and the pipe is aligned on the bottom of the trench. With the help of the restrained push-in joint, the next pipe is assembled and the trench is ready for backfilling again. This means that the construction site remains very manageable. A further advantage of ductile iron pipes lies in the fact that they can be laid in rocky ground without any special bedding material [2].

3 Logistics

Because of the topography and the roughness of the terrain, the Epp construction company from Bristen (Switzerland), the Arnold AG installation company from Schattdorf (Switzerland), the pipe manufacturer Duktus (Wetzlar) GmbH & Co. KG from Wetzlar (Germany) and the pipe supplier TMH Hagenbucher AG from Zürich (Switzerland) were facing a challenging logistical task. This was further aggravated by the fact that a total of 50 special adapter pipes had to be made to measure at short notice so as to be able to adjust the pipeline to its route. At this point the experience of the pipe supplier and their technical equipment for working with the ductile iron pipes were of the highest value.

4 Construction of the pipeline

The construction of the pipeline began in April 2016. In the initial phase the DN 1000 ductile iron pipes had to be transported from their storage location at Amsteg im Reuss valley along 3 km of mountain road in the Maderaner valley to Bristen. A tractor with trailer was used for this which, loaded with up to three pipes, was manoeuvred along the narrow, winding road **(Figure 1)**.

Figure 1:
Transporting the DN 1000 ductile iron pipes in the Maderaner valley

Figure 2:
Assembling a ductile iron pipe "upside-down"

From this interim storage area onwards, a crawler excavator then carried each pipe individually to the pipe trench. The power plant pipeline was built uphill, against the direction of flow, so that the pipes and fittings had to be assembled "upside-down" **(Figure 2)**.

In the normal case, to do this the pipe trench was excavated over a length of around 6 m, the pipe aligned and the trench backfilled directly afterwards. An excavator with a screening bucket was used for this, so that the excavated material could be broken up and put back straightaway. Thanks to the efficient chain of transport, the reliable BLS® restrained push-in joint, which can be safely and rapidly assembled even under these difficult installation conditions, and the robust exterior protection of the pipes with cement mortar coating, the experienced assembly engineers from Arnold AG (Rohreinbau) were able to work at a rate of up to 60 m a day.

The special pipes, such as the adapter pieces before changes of direction **(Figure 3)**, were made to measure at the Hagenbucher centre of competence in Eglisau, about 120 km away, within 2 to 3 working days **(Figure 4)**, ready to be transported to the construction site for installation. This work was able to be done at the centre of competence regardless of weather conditions. In detail, the pipes were cut to length, the cement mortar coating was removed to the appropriate length, the pipe ends were chamfered and a welding bead was applied around the circumference by means of an automatic welder **(Figure 5)**. Finally, a corrosion protection coating was applied to the pipe ends, consisting of a zinc coating and a bitumen finishing layer.

Figure 3:
Installation of a 22° double socket bend (MMK 22) and an adapter pipe for a change of direction

Figure 4:
An adapter pipe being put together at the Hagenbucher centre of competence in Eglisau

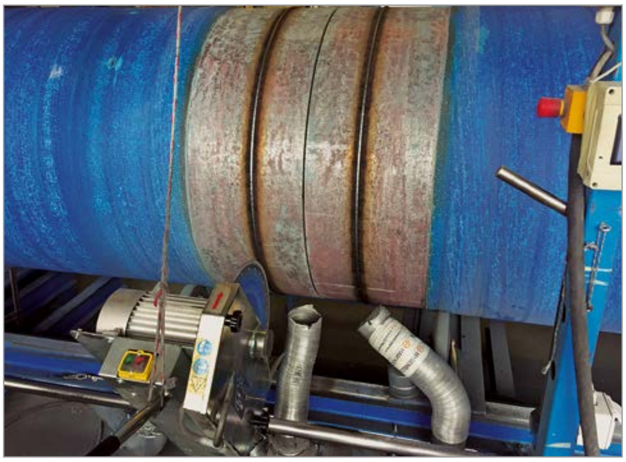

Figure 5:
Welding beads on the spigot ends of two adapter pipes

Figure 6:
Backfilling the pipe trench and restoring the surface in difficult Alpine terrain

While this was being done, the construction company was backfilling those areas of the pipeline which were still open **(Figure 6)**, meaning that at no point was the construction work delayed on account of the preparation of the special pipes.

5 Power plant building and power plant pipeline

In order for the power plant – consisting of the water catchment in the "Lägni", the 1,800 m long power plant pipeline and the power plant building at the valley station of the Bristen-Golzern cable-

Figure 7:
Steel construction of the footbridge with pre-assembled DN 1000 cast iron pipes underneath the bridge

Figure 8:
A view under the footbridge with the curved steel girders – the ductile iron pipes follow the contour of the curve

way – to blend harmoniously into the landscape, the water catchment has been concealed behind a rock, the power plant building has been designed as a showpiece power plant with a gable roof and the power plant pipeline has been installed underground. Only in one section did the pipeline have to be run above ground, suspended beneath a pipe bridge over the Chärstelen stream. With the deflection capability of the BLS® restrained push-in joints, the pipeline is able to follow the curved shape of the bridge without the use of additional fittings **(Figure 7)**. After completion of the construction work, the pipe bridge will be upgraded into a footbridge and the pressurised water pipeline beneath it will not be visible from above **(Figure 8)**.

The entire power plant pipeline was completed within just seven months. In the 1,800 m long pipeline there are 40 fittings (double socket bends MMK 11 to MMK 45), three fittings with manholes **(Figure 9)** and 50 special pipes installed.

Figure 9:
One of three manholes along the route of the power plant pipeline

As the main building with the turbines is located directly next to the valley station of the Golzern cableway so popular with hikers and mountain bikers, the Bristen power plant will also act as a showpiece power plant. In this way, as well as the actual production of energy, it can contribute added value for tourism in the Maderaner valley.

6 Data on the project

Client:	KW Bristen AG
Catchment:	Lägni, 1,007 m above sea level
Power plant:	Schattigmatt, 827 m above sea level
Gross head:	180 m
Pressure pipeline:	1,800 m ductile iron pipes with BLS® restrained push-in joints and cement mortar coating
Fittings:	40 socket bends, DN 1000, in ductile cast iron – MMK 11° to MMK 45° with BLS® restrained push-in joints

Bibliography

[1] Eberhard, S.:
A project for the future –
construction of a new hydropower plant in Bristen
Bulletin 11/2016,
Published as a special edition:
www.kw-bristen.ch

[2] CONSTRUCTION STARTS ON THE GREEN POWER PLANT AT CHÄRSTELENBACH IN THE CANTON OF URI
Appeared in ZEK Hydro
April 2016 issue, p. 47

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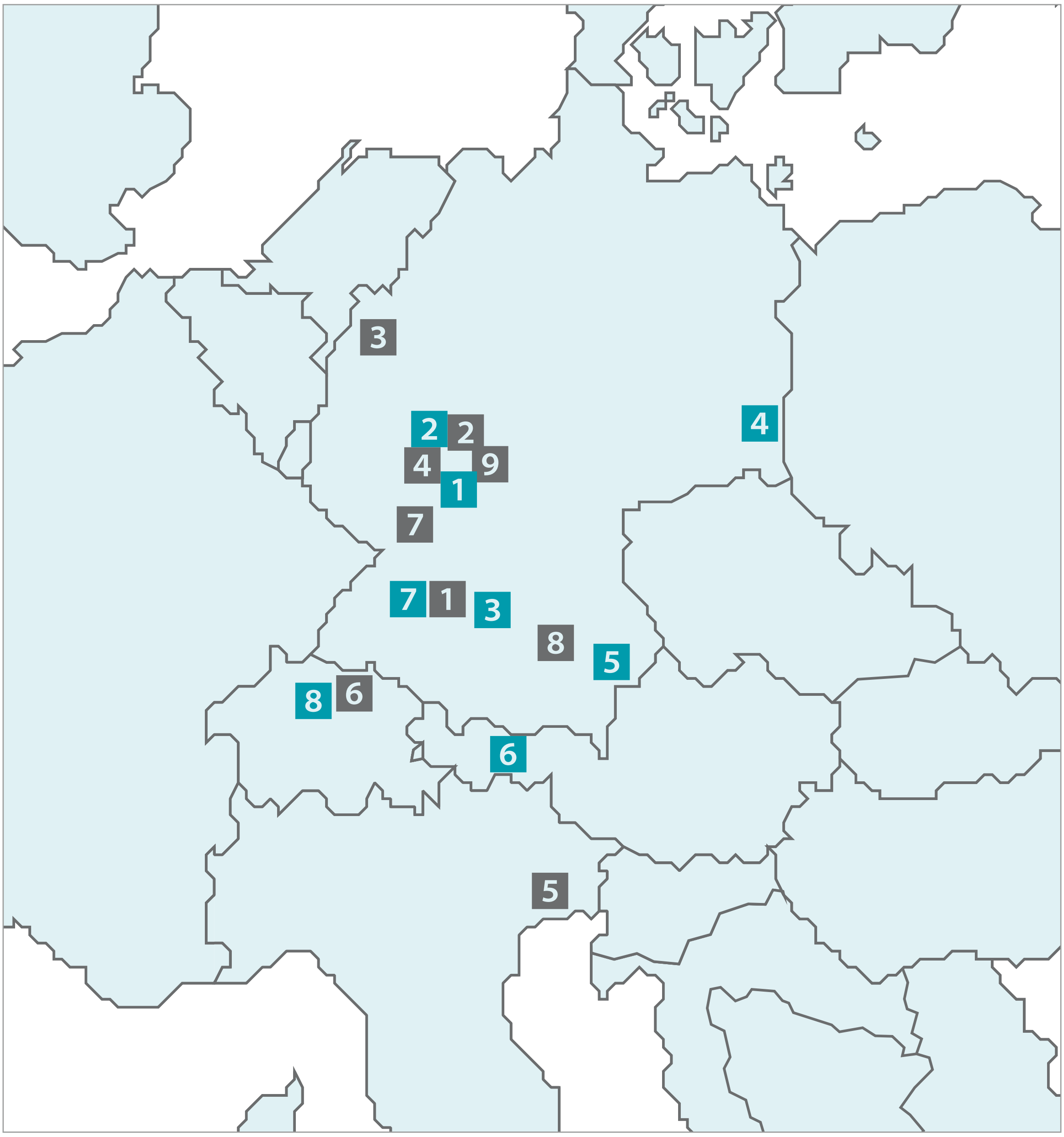

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NEWSLETTER

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NEWSLETTER

Dear Readers,

In this, the last Newsletter of 2016, I am reporting on projects in Austria, Switzerland and Norway. Ductile cast iron is used in a variety of ways. But pipes, fittings and valves are always the key element in the thinking here. With this in mind, one article looks at the further development of renewable energies. Robust and operationally reliable ductile iron pipes are given priority for use in power plant pipelines.

Security of supply for drinking water takes centre position in the second piece about a major project in Switzerland which, naturally, includes the installation of ductile iron pipes as the transport pipelines from newly developed drinking water extraction areas. In the third contribution I am reporting on another area where ductile iron pipes are used. Ductile driven piles have been used as foundation elements for around 30 years. You can see what these piles look like after 30 years of service in article no. 3.

Dear Readers, we would like to close by wishing you a successful start to 2017.

Have an enjoyable and stimulating read

Sincerely yours

Christoph Bennerscheidt

750 m of ductile iron pipes for the turbine pipeline

In Ullensvang in the Norwegian province of Hordaland, with Bergen as its capital city, Sunnhordaland Kraftlag (SKL) is building a new hydropower station. Ductile iron pipes were used for part of the turbine pipeline.

Read on ...

New drinking water transport pipelines for Bellinzona in the Swiss Canton of Ticino

Bellinzona is the capital and, after Lugano, the second largest city in the Canton of Ticino (Switzerland). For the past 6 years Aziende Municipalizzate Bellinzona AMB, the utility company for the ...

Read on ...

30 years of ductile cast iron driven piles

On the occasion of a technology transfer (licence agreement) between the companies Tiroler Röhren- und Metallwerke AG and AB Gustavsberg in 1986, the ductile driven pile came to Austria, where its history of success began.

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