Pipeline Materials Selection – Reviewing the Essentials

First Published in the Water and Sanitation Magazine

Allistair Balutto   Rexus Pty Ltd
Tel: 011 392 4815   email: allistair@rexus.co.za

Introduction

Pipeline materials selection is often a complex and sometimes controversial process. Selection complexity is compounded by the diverse choice of available materials each offering a wide spectrum of attractive properties and viable benefits. However, every water or wastewater conveyance system is unique and no pipe material is necessarily suited for every application as all pipeline materials may present benefits in one area but may be lacking in others.

Materials selection for this reason should be an optimising and multidisciplinary process that selects a material for the sum of all its properties. The initial capital cost of each material under consideration should be carefully weighed against optimum performance of the material and the sum of all costs during the total lifetime of a pipeline system. In short, all pipeline materials selection decisions should ultimately be governed by only two major factors namely cost (both capital and life cycle costs) and performance.

Pipeline materials have inherent properties and display distinct characteristics under specific operating conditions. This document evaluates a few critical applications and touches on some of these considerations when selecting pipeline materials. Highlighted are the most popular materials currently in use in the South African market.

Pipeline Materials Selection Market Overview

A reflection on the South African pipeline industry today compared to 20 years ago indicates a major change in pipeline material choices. Whilst some materials have endured the test of time and have improved due to better marketing, manufacturing and coating and lining processes, others have been discontinued due to repetitive failures, changes in legislation or cost factors.

Pipeline material selection for the Water industry has evolved into very clear patterns based on pressure, pipeline diameter and application. Today traditional Plastics such as High Density Polyethylene (HDPE) and Polyvinyls (uPVC and mPVC) tend to dominate the low to medium pressure and small diameter pipe market whilst Steel dominates the high pressure and larger diameter applications.

Materials such as Ductile Iron and Glass Reinforced pipe (GRP) have also substantially grown in popularity but have tended to find specific niches. Ductile Iron's growth has been in the medium to high pressure and small to medium diameter applications and GRP has grown in the medium to large diameter, low pressure water applications specifically along the coastal areas.

Whilst there are some challenges to this current status quo with Plastics being considered for larger diameter applications and Ductile Iron Pipe making inroads in areas more traditionally reserved for both Steel and Plastics, the market still adheres relatively rigidly to the status quo. This is reflected in the meters of pipe sold per annum which is still dominated by Plastics, followed by Steel with Ductile Iron pipe and GRP tailing modestly behind these two materials.

The market structure for different material preferences is based on several factors including availability, performance and cost. However, material choice may also be restricted by tradition, where some users prefer specific materials based on historical factors and by perceptions of either benefits or restrictions for materials without the rigorous assessment through an optimising process.

Some Considerations when Selecting Pipeline Materials

Pipelines contribute the largest initial capital cost and, if materials of construction are not suitable for the application or, the pipeline is not laid to applicable standards, will contribute to the largest overall maintenance costs. Considerations beyond initial capital costs and availability should include:

Pipeline Jointing

One common area for failure of liquid pipeline systems is at or within the interconnecting point. It is, therefore, vital to select jointing systems and materials that are reliable and suitable for the expected operating environment.

Depending on the pipeline material, a pipeline is joined every 6, 12 or 18 metres. Every pipeline material has developed one or several different methods of jointing. The integrity of the joint is one of the determining factors for the success of an installation.

The bell and spigot joint designs utilised in Ductile Iron Pipe and PVC pipe have proven their reliability with time. The PVC joint displays a dynamic characteristic well suited for the flexibility of the material as the seal will adjust with the pressure fluctuations to ensure a positive seal under all operating conditions.

In the Ductile Iron pipe joint, integrity is guaranteed in several ways. Firstly, the rubber gasket is keyed into the socket to prevent it being pushed out during installation; secondly, the leading edge of the gasket is of a higher shore hardness than the sealing face of the gasket, this prevents damage to the gasket during installation. Thirdly, the seal is a pressure fit which allows for integrity of the seal under vacuum conditions and lastly, the seal has a dynamic characteristic which increases the sealing benefit as the pressure increases.

Both PVC and Ductile Iron pipe provide self contained restraint jointing systems where needed. These joints eliminate the need for thrust blocks and are applicable in high built up areas with space constraints or areas with loose soils where the casting of thrust block may not always be suitable. In addition, there is available on the local market, a SABS tested quick flange adaptor system that allows for the flanging of any spigot ended PVC pipe in a matter of seconds therefore cost effectively and efficiently restraining the joint where required.

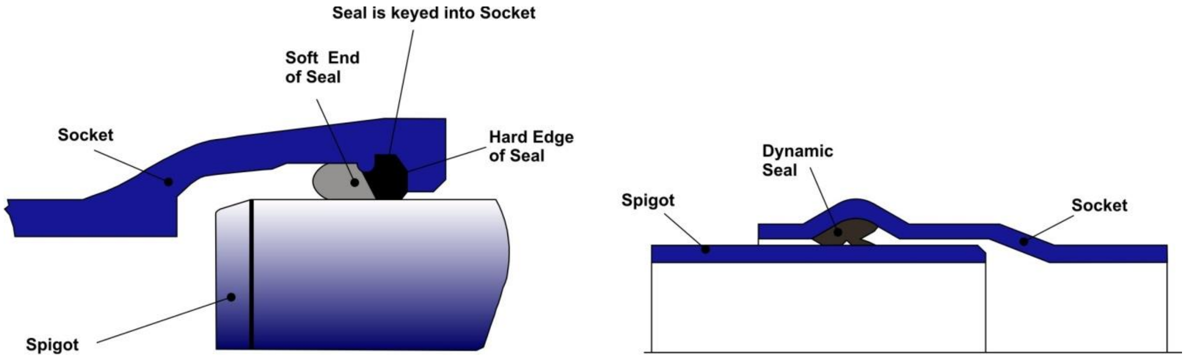

Diagram 1

On the left is the Ductile Iron Pipe spigot and socket joint indicating how the rubber seal is keyed into the socket as well as the fact that the gasket has a hard end to prevent damage during insertion and as soft sealing edge. On the right is a PVC spigot and socket joint indicating the dynamic rubber seal.

PVC and Steel pipe in some applications makes use of a Victaulic Clamps as a jointing system. This system of jointing has proven very reliable. However, it is important for buried applications, that the joint is protected with a heat shrink sleeve. Further, it is important in PVC applications to ensure that the metal collar is installed correctly to prevent failure under operation conditions.

The most popular jointing method for Steel and large diameter HDPE pipe is welding. The benefits of a correctly welded pipe joint are many. However, ensuring the integrity of a welded joint presents several challenges in both materials.

In the case of Steel pipe, the challenges presented is not only the assurance of a good quality weld in the field but effectively covering the cutback, after the weld has been made, of the external coating to an equal quality to the coated pipe. Further, if the pipe is mortar lined then the internal surface where the weld has been made needs to be covered. However, the quality of the mortar on the joint may not often be to the same density as the rest of the pipeline and therefore can be knocked off as a result of external loads and surge conditions.

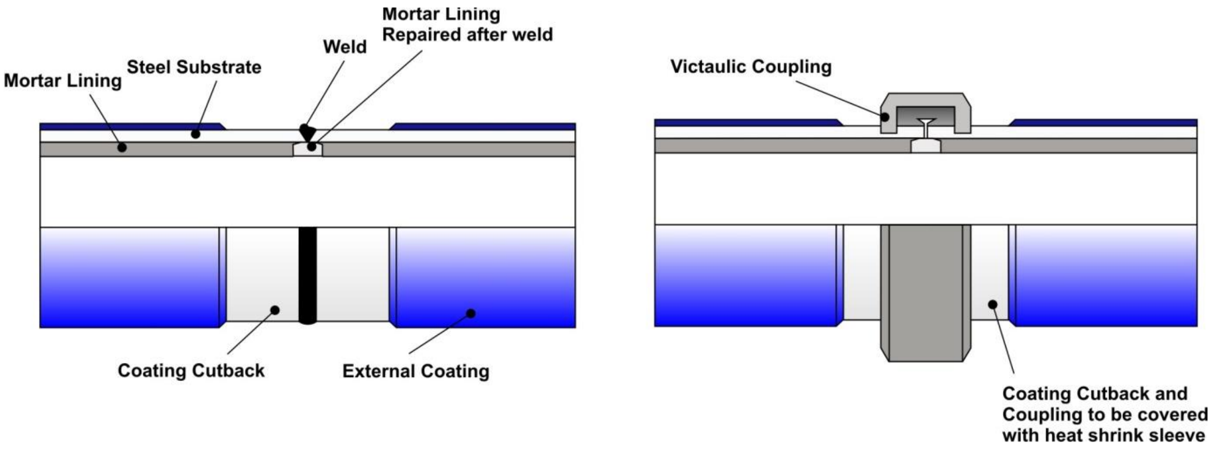

Diagram 2
On the left is a typically welded Steel application indicating the coating cutback that needs repairing as well as the mortar lining that needs repairing after the weld has been made. On the right is a Victaulic clamp arrangement on a Steel pipe indicating the cutback and the Victaulic clamp that needs to be covered with a heat shrink sleeve.

Thermal butt-fusion used for joining HDPE pipe requires well trained personnel. Correctly made butt fusion joints are as strong as the plain pipe. However, the control of the melt temperature as well as prevention of contamination of the welding surfaces is highly critical to producing a good butt weld.

Careful matching of the pipeline thicknesses and the grade of HDPE are also critical factors to the success of a field weld.

Most fittings for HDPE pipe are fabricated. Though it is not commonly practiced, it is recommended that a pressure derating factor of 25% is applied for any fabricated fittings such as bends and tees which require a mitre joint to assure that the fitting is of equal pressure rating with the pipe. Alternatively, moulded fittings should be utilised which are often more expensive but better suited to ensuring the pressure integrity of the pipeline.

HDPE also utilises compression fittings to join smaller diameter pipe. Compression fittings provided they are correctly installed have proven extremely reliable in diameters of 110mm and smaller. Stub ends with loose metal flanges are also used as a jointing system for HDPE pipe. However, the joint is highly reliant on the quality of the weld and the compatibility of the stub end material with the pipe material. It is recommended when utilising this type of joint, to ensure that the pipe is “snaked” in the trench to provide slack for expansion and contraction. If utilised above ground then, there should be sufficient expansion joints installed to assist in taking up the contraction and expansion of the pipeline.

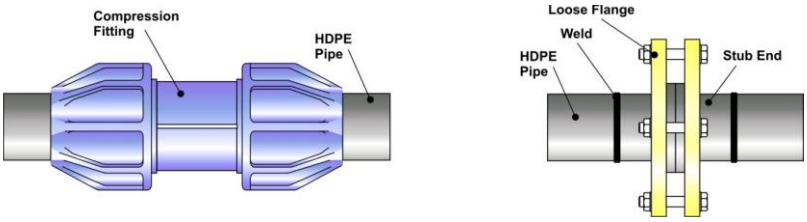

Diagram 3
On the left is a compression fitting suitable for HDPE up to 110mm. On the right is a stub end with loose flange arrangement. The sub end gets welded to the pipe on site. This arrangement is common in industrial application. The joint is only as strong as the integrity of the weld.

Another common method of joining HDPE pipe is the use of electrofusion welded fittings. This method if correctly applied provides a homogeneous joint with the same characteristic as the parent pipe. Electrofusion welded fittings consist of resistance wires embedded into the material of the fitting which, when heated by a controlled electrical current, cause the surrounding HDPE material to melt and form a fusion joint.

Extensive research into electrofusion welded applications indicates that greater success in the integrity of the joint is achieved if the pipe surface is scraped prior to the fitting being joined as this is the most effective method of ensuring an uncontaminated welding surface.

Recent developments in the South African market have seen the introduction of several restrained mechanical joints that makes the joining of HDPE easier and more cost effective. The most recent is a quick flange adaptor that has undergone SABS testing for pull out tests with results indicating that the adaptor cannot be pulled out therefore providing a fully restrained joint. This adaptor allows for the quick flanging and restraining of any spigot ended HDPE pipe.

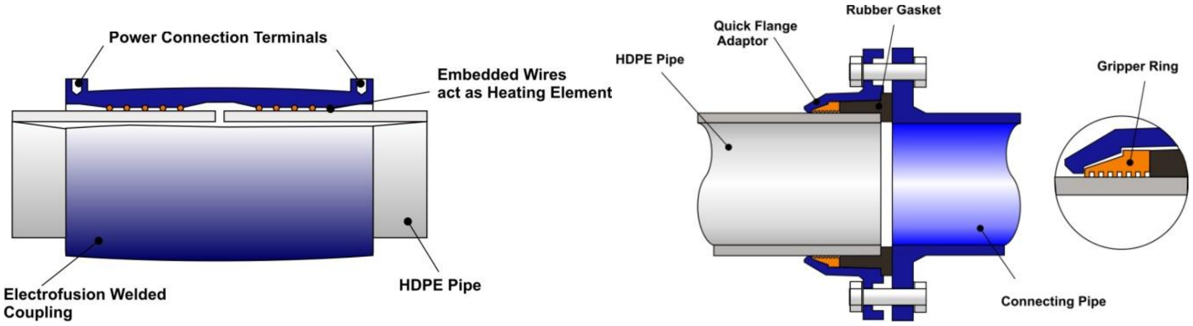

Diagram 4
On the left is an electrofusion welded fitting which is fusion welded on site. It is important to scrape the HDPE pipe before the coupling is installed for maximum adhesion. On the right is a Quick Flange Adaptor that ensures quick flanging of HDPE and PVC pipe and which provides a fully restrained joint eliminating the need for thrust blocks at bends and changes in direction.

GRP pipe has developed several reliable jointing systems. However the material has often, due to cost constraints, utilised mechanical coupling as a method of jointing. Failure in these applications are virtually inevitable due to the ability of the pipeline material to flex under various pressure conditions whilst the sealing position of the mechanical coupling remains static once the initial seal has been made.

The most reliable GRP jointing is a spigot and socket system. This method is seldom utilised in South Africa due to cost constraints as the joint can be 30% or more than the cost of a full length of pipe. Another reliable and more cost effective system is short fabricated double bell couplings with a dynamic rubber sealing system where the sealing improves as the pipe pressure increases. Care should be taken on large diameter GRP pipe applications to release any entrapped air in the joint to ensure that the pipeline can be fully pressurised.

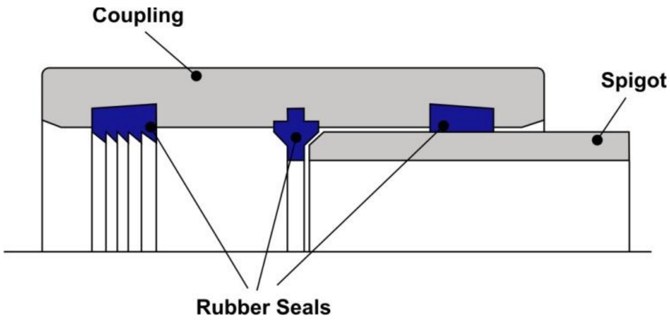

Diagram 5
GRP makes use of a double bell coupling with three seals to ensure the integrity of the joint.

Surge and Waterhammer

Surge and waterhammer in a pipeline system is inevitable if design precautions are not taken. These destructive phenomena can be aggravated by the nature of the pipeline profile, the pipeline flow velocity, pipeline component selection and pipe laying practice.

Surge and waterhammer is often associated with bulk water pumping mains but frequently occurs in gravity and networks systems or wherever a control device is utilised.

Pipe material selection plays a critical part in addressing the surge and waterhammer phenomena.

Most pipeline materials are designed to deal with an overpressure due to waterhammer of between 1.4 and 1.5 times the designed working pressure. However, it is both surge (mass oscillation) and waterhammer (rapid transient) that should be considered when selecting a pipeline material.

PVC and HDPE, under waterhammer conditions, have a unique ability due to the materials' entangled molecular chain structure, to withstand extremely high short duration stresses without incurring damage. However, Plastics in general may be susceptible to cyclic failure as a result of mass oscillation. The magnitude of the pressure waves created by mass oscillation may never reach the working pressure of the pipeline but a pipeline subjected to repetitive oscillating may result in failure. Mass oscillation is often exacerbated by the smooth inner surface of Plastics as oscillations in this fashion are partly or totally dependant on the pipeline friction to bring the pipeline to a steady state. The selection of quick acting non return valves and proper selection of air valves help minimise the mass oscillation phenomenon.

Engineers when specifying specifically PVC pipe, often accommodate for cyclic surges by specifying a higher pressure class than the design requirement to ensure a large safety factor. This practice should extend to HDPE for large diameter pressurised applications

Large diameter, thin walled Steel pipe is frequently specified with a mortar lining. When the rigidity of the two materials are considered then mortar and Steel are at opposite ends of the scale with mortar being the most rigid of pipeline materials and Steel being one of the most flexible. While the mortar lining prevents tuberculation in pipelines, it presents a challenge under surge and waterhammer conditions as the behaviour of the mortar is substantially different to that of steel.

Care must therefore be taken in the surge protection strategy to limit the negative pressures to within two metres negative differential for the down surge (lowest negative pressure) and to minimise the magnitude of transients for the upsurge (maximum positive pressures). Whilst it is common design practice to design for a surge pressure equivalent to 75% of Steel pipe's yield strength the concrete lining may not be able to withstand transients of this magnitude. Excessive high or low pressures may result in spalling where the mortar lining is dislodged from the steel pipe wall.

Ductile Iron is also a mortar lined ferrous pipe similar to Steel. However, the method of application of the mortar lining for Ductile Iron ensures a high density lining. In addition, the pipe has a high graphite content which assists in attenuating surges. In smaller diameters, Ductile Iron behaves like a semi rigid material this minimises spalling under surge and waterhammer conditions. The same precautions as for Steel are applicable in managing the negative differential pressures under surge and waterhammer conditions for large diameter thinner walled K7 pressure class Ductile Iron pipe.

GRP pipe is a composite material that consists of resin impregnated fibre glass strands wound around a mandrel to form the pipe. Layers of silica are sandwiched between layers of fibre glass to provide stiffness. Pipe with lower stiffness values (SN values) tend to better handle negative pressures under surge conditions than more rigid pipe with higher SN values. Low negative pressures can cause delamination of the layers. It is therefore recommended to limit the negative pressure differential under surge or drainage conditions to two metres.

Pipeline Installation

Today most pipeline materials are highly engineered and if correctly installed provide a good balance of strength, stiffness, toughness and durability to meet the demands of the water pipe industry.

However, site construction error of installed pipe systems is a major contributor to pipeline failure with the actual laying of the pipeline being one of the most overlooked areas. A good understanding therefore of pipe/soil interaction is critical to the sound structural design of pipelines.

While the concern for soil pressure on a pipe is higher in sewer and stormwater applications where the conduit never flows full , it is of importance in pressurised water pipeline applications too. This is specifically true during the initial laying of the pipe and in the time period it takes the soil to settle around the pipe installation. The internal pressure of a pressurised system is typically much greater than soil pressure on the pipe and therefore with time for settlement in the soil, supports the soil load.

Today, all pipeline materials used in pressure water applications are considered flexible materials. This implies that the pipe flexes to a degree under buried conditions without any structural damage caused to the pipe. As a result of the pipe's vertical deflection of the soil, the pipe is relieved of part of the vertical soil load, which is deflected to the side to form an arching action over the pipe.

As a general rule, mortar lined pipes like Steel and Ductile Iron are allowed to flex up to three percent whilst epoxy coated Steel, GRP, HDPE and PVC are allowed to flex up to five percent.

Caution should be taken to prevent flexing beyond these limits. This is specifically true for GRP where the material can delaminate and for thin walled Steel where spalling of the mortar lining can occur if flexed too much.

Some pipe materials such as Ductile Iron exhibit characteristics of both rigid and flexible pipes, primarily controlled by the wall thickness vs. diameter relationship, and are referred to as semi-rigid pipes. The benefit cannot be quantified through pipe/soil calculations as design requirements are to treat a semi rigid pipe like a flexible pipe. However, the benefit of this characteristic can be experienced on site where Ductile Iron Pipe is more forgiving in the handling, bedding and compaction requirements in comparison to any other pipeline material utilised for pressurised water.

It is important in the design of buried pipe to account for the soil load (dead load) and where applicable, for live loads such as moving vehicles when a pipe is buried under a highway or railroad embankment. The value of soil load analysis is to arrive at the required pipe strength necessary to build a pipeline of sufficient structural integrity to serve its design life. The design process varies from pipe material to pipe material.

For HDPE, PVC and GRP pipe, stress concentrations caused by enviromental factors such as rock impingement or scratches will act as crack initiation points. Care must specifically be taken with HDPE pipe as a scratch a milimetre deep will lead to the pressure deteroriation of the pipe and the deeper the scratch, the lower the pressure will be that the pipe can carry.

The coefficient of thermal expansion and contraction of HDPE is higher than metal. For the same change in temperature, unconstrained HDPE pipe expands about eight times as much as a metal pipe. Installation must prevent the development of excessive pipe contraction forces which, while normally not damaging to the pipe, can produce higher than desirable pullout and bending loadings at the point the pipe connects with a rigidly held fitting.

Care should be taken in HDPE applications when utilising chlorine as a disinfectant. Both the recommend free chlorine and residual chlorine dosages should strictly be adhered to. Daily amounts of chlorine should also not exceed maximum levels at temperatures in excess of 24° C.

HDPE pipe should be laid with some slack and should be “snaked” in the trench to accommodate any contraction resulting from cooling prior to backfill. The slack also provides for active soil friction development once the pipe is buried and placed in service. This soil friction helps to reduce stress concentration at pipeline terminations and connection of the pipe when temperatures fluctuate during operation.

To reduce tension stresses and pull out stresses due to thermal contraction, HDPE pipe should be allowed to cool in the trench before backfilling or connecting to components such as tees, valves and meters.

Pipelines installed in Dolomite areas should be flexible and the integrity of the joint should be maintained when ground movement occurs. This traditionally has limited the choice of pipeline materials utilised in these areas. However, a good case can be made for the suitability of Ductile Iron pipe in these applications.

Ductile Iron Pipe is supplied in 5.7 or 6 metre lengths and provides up to five degrees of deflection in its joint. Further, the pipe as part of the annealing and casting process undergoes a structural change from the outer to the inner surface that results in distinct layers with different hardness values very similar to the effect of a composite bow. This feature very much like a bow allows for the deflection of the pipe when a large force is exerted on it but, for the pipe to return to its normal shape once the pressure upon it is lifted. This implies that the pipe can deflect at the joint and along its length and still maintain the integrity of its seal. Ductile Iron Pipe’s performance in earthquake prone areas is well documented where the pipe often presents the lowest failure rates of all pipeline materials. It would be reasonable therefore considering the pipe material’s characteristic and performance under these conditions to deem it suitable for use in Dolomite areas.

Corrosion Resistance

The selection process for a corrosion resistant pipeline material should consider compatibility with environmental conditions. Additional factors should include fabrication and installation costs, support system complexity and in the case of ferrous material, cathodic protection requirements

Pipeline corrosion is a multi-faceted process that is very complex. However, the underlying processes rely on the availability of water and oxygen. Soil conditions, overhead power lines and railway tracks also give an indication of the probable corrosion process that can take place.

A Steel pipe coating’s primary role therefore is to isolate the environment from the Steel substrate. It should be an effective moisture barrier, a good electrical insulator and have excellent adhesion to the pipe surface. The applied coating should resist damage associated with normal handling, storage and installation. If a pipe is to be stored outside for long periods then the ability of the coating to withstand UV degradation is important.

The choice of pipeline coatings and linings should be based on fitness for purpose which includes installation and operational requirements that can be expected for the pipeline and not primarily on historical choices as is often the case.

For Steel pipe specifically, pipeline integrity starts with an effective pipeline coating that is then augmented by cathodic protection. As long as the coating remains bonded to the steel and isolates the environment from the metal then the risk of corrosion related failures is minimised. A recent survey in the USA found that the primary cause of loss of corrosion protection was coating deterioration and inadequate cathodic protection.

Pipeline coatings for Steel pipe have advanced substantially over the past 30 years. Today, whilst galvanised steel pipe is still widely used specifically in small diameter applications and for fabricated fittings, there is a preference for more advanced coatings in bulk water supply applications.

One of the advancements has seen a greater use of three layer polyethylene coatings which consists of a layer of fusion bonded epoxy for corrosion protection, followed by a co-polymer adhesive and a protective polyethylene layer which provide for protection against mechanical damage. This coating properly applied and installed, provides one of the best forms of external protection for steel pipe

Another coating and lining technology rapidly growing in popularity is rigid polyurethanes. Reasons for this growth are based on the rapid curing of the coatings and the fact that the coatings can be applied to almost any thickness on any diameter or length of pipe. Rigid polyurethanes form a three dimensional, cross linked structure, thus providing the coating film with good resistance to chemicals, water penetration and cathodic disbondment.

Epoxy Coatings and Linings still remain popular for fabricated Steel fittings or coastal pipeline installations.

Regardless of the coating or lining utilised for Steel pipe, the challenge remains on how well the joint is coated after welding as a mismatch in coating integrity between the pipe and the joint will result in future corrosion. Minimising deflection to no more than 3% for rigid coatings and linings and 5% for flexible coatings and linings under installation conditions is imperative to prevent disbondment and potential corrosion.

Ductile Iron Pipe as a ferrous material shares some properties with Steel but due to its jointing system and manufacturing processes behaves differently to corrosion conditions.

As part of the manufacturing process, Ductile Iron pipe is annealed to relieve the casting stresses from the pipe. This results in the formation of a corrosion resistant oxide layer on the outside surface of the pipe. The oxide layer in conjunction with the applied pipe coatings plays a part in providing an inherent resistance of Ductile Iron Pipe to corrosion in most soil environments.

Because of Ductile Iron Pipe’s spigot and socket jointing system, there is disbondment between every length of pipe. This implies that stray currents can at the most only affect only one pipe.

Ductile Iron Pipe is supplied as standard with a zinc and bitumen external coating. However, this material can, depending on soil conditions, also be supplied in a variety of other coatings including an epoxy or polyurethane external coating. In very aggressive soils, the pipe is often supplied with a loose polyethylene casing which provides complete isolation between the pipe and the soil. Should water enter between the pipe and the casing then, the oxygen would be starved in the water, rendering it inert and therefore not harmful to the pipe.

It is often a misconception that Ductile Iron Pipe cannot be crossbonded. The material, though rarely needed, can be crossbonded cost effectively through thermal welding which does not affect the molecular structure of the pipe. Often, when cross bonding is utilised, it is done in conjunction with a loose polyethylene sleeve for ultimate protection. It has to be stated that crossbonding is not a preferred method of corrosion protection for Ductile Iron Pipe as it imposes an unwanted maintenance requirement which is not always fulfilled due to a shortage in skilled staff to carry out the maintenance or due to cost constraints. In addition the material offers so many other corrosion protection benefits as highlighted above, that crossbonding is seldomly needed.

Cement mortar lining is the most predominant lining used for potable water and sewage rising mains in both Ductile Iron and Steel pipe applications. Standard cement mortar lining is not suitable for sewage pipelines that are septic and produce sulphuric acid and for soft waters. In Ductile Iron applications, either high alumina cement is utilised or, the cement mortar lining is coated with epoxy rendering it inert and therefore impervious to attack from sulphides or soft waters.

Pipeline Sizing and Energy Consumption

The sizing for any piping system consists of two basic components namely; fluid flow design and pressure integrity design. Fluid flow design determines the minimum acceptable diameter of the piping necessary to transfer the fluid efficiently. Sizing of pipelines should take into account the pipeline’s internal diameter and headloss characteristics and, the pipeline profile in line with pump selection.

Pressure integrity design determines the minimum pipe wall thickness necessary to safely handle the expected internal and external pressures and loads. When stepping up pressure ratings for pipeline materials with constant outside diameters such as PVC and HDPE then, energy consumption costs and increased velocities and the impact of surge and water hammer should be taken into account.

The amount of energy consumed by a pipeline's pump/s is dependent on the pipeline profile, pipeline material, pipeline diameter and the pump/s selected. Headloss across pipeline components or any other restriction in a pipeline will also have a major effect on the amount of energy consumed.

Pipeline materials with the same headloss characteristics but different internal diameters for the same nominal size may therefore have an effect on the amount of energy consumed. Similarly, a pipeline material with a higher headloss characteristic but a larger internal diameter for the same nominal size may in fact, have a lower energy consumption than a pipeline material with a lower headloss characteristic but smaller internal diameter.

This can be demonstrated when comparing a K9 DN200 Ductile Iron Pipe with a 200mm Class 16 PVC pipe. Both have a nominal diameter of 200mm. However, the internal diameter of the Ductile Iron Pipe is 203mm, while the internal diameter of the PVC pipe is 182.8mm. For this example, Ductile Iron Pipe provides a 23% larger flow area compared to the PVC pipe and even if the difference in roughness coefficient of the two pipe materials are taken into account, Ductile Iron pipe still provides a 16% larger flow area and therefore reduced energy consumption compared to the PVC pipe under equivalent operating conditions.

Air Release and Vacuum Protection

It is important, regardless of the pipeline material, to release air in a controlled manner spacing air valves in accordance to the pipeline profile and diameter. However, it is important to provide adequate accumulators in the form of unequal tees with the vertical branch of the tee a minimum of 1/3rd the diameter of the main pipeline as air may otherwise be swept past the air valve and accumulate downstream creating surges and restrictions in flow and high energy consumption as pumps are forced to work at higher heads in order to overcome the restrictions.

Pipelines need to be filled at moderate rates of no more than 0.5 m/sec to prevent surges from rapid air release. Surges created by rapid air release are cumulative and concentrate at points of weakness such as reductions in pipe class, fittings which may be of a lower standard than the surrounding pipes, near line valves or tapers and in branches with closed ends. These surges, in addition, result in the structural failure of pipes due to the combined effect of the surge pressures which crack protective pipe linings and the retained air pockets which promotes corrosion. Surges if not managed can also cause cyclic failure in Plastic pipes.

Caution should be taken to limit the negative differential of thin walled Steel pipe, GRP, HDPE and PVC to two metres negative differential pressure. It is also important to size and position air valves adequately as too many air valves on a pipeline are as damaging as having too few. Similarly over sizing an air valve is as damaging to a pipeline as installing air valves that are too small for the system.

Pipeline Component Selection

Pipeline component selection has a major impact on the performance of any pipeline system regardless of the materials of construction utilised. It is imperative therefore that a component is selected with a good understanding of its behaviour across the entire operating cycle of a pipeline. Further, components such as non return valves, air valves and control valves specifically should be evaluated for their impact on surge pressures, contribution to energy consumption and/or maintenance requirements.

Conclusion

Evaluating pipeline materials on a technical basis in order to write a fair specification can be overwhelming. This is specifically true when it seems that more than one material qualifies. However, material selection as this document adequately demonstrates is an optimising process, and there must be one material through this process that will be the best overall choice for a particular application.

The number and availability of material options in today's industry have grown tremendously and have made the selection process more complex than a few decades back. As research and development in the materials sciences continue to grow, selection will become even more complex. This article touches on those areas that will be relevant regardless of how materials develop and brings the decision back to the ultimate two deciding factors namely that of cost and performance relative to application.

It is the author's hope that through this brief article, specific areas are highlighted where perhaps a greater focus should be given when designing and laying pipelines to ensure pipeline systems are cost effective and sustainable.

About the Author:

Allistair P. Balutto comes from a petrochemical and mechanical engineering, marketing and entrepreneurial background and has been involved in the Fluid Conveyance Industry for more than 30 years.

He holds patents in valve design and, has in the last 30 years developed and co-developed several successful products, markets and business concepts.

Allistair has lectured extensively on Pipeline Engineering, Business Management and Market trends in the Pipeline and has authored several technical papers and publications on Hydraulic Design and Valve Engineering principles and general Pipeline Design. Some of his writings are globally referenced and has become part of the syllabi of learning institutions.

Contact:

Rexus Pty (Ltd)

Tel: +27 11 392 4815 | **Tel:** +27 71 885 8574

E Mail: marketing@rexus. co.za | **Web:** www.rexus.co.za

19 Simba Street, Sebenza, Edenvale, Gauteng South Africa