Optipipe ™

Wear Technologies

What is Optipipe™

Optipipe is a new kind of engineering thermoplastics with more than 3 million viscosity-average molecular weight. Ultra-high molecular weight polyethylene pipe has superior performance over conventional HDPE pipe such as very high wear resistance, impact resistance, excellent resistance to internal pressure strength, resistance to environmental stress cracking, intrinsically self-lubricating, anti-adhesion, low temperature resistance and excellent chemical resistance.

Performance Properties

Optipipe pipes are ideal for the transport of powder and coal ash in thermal power system, backwater pipelines, the transport of mine tailings and slurry in the mining industry, the high-pressure transport of pulverized coal and coal-water slurry of coal preparation plant in the coal industry, as well as the transport of mud and corrosive media with slag in other industries.

Optipipe is 1/8 the weight of mild steel but is high in tensile strength.

Also, unlike steel, Optipipe is an inexpensive alternative to metals and ceramics, and because it is self-lubricating, long-wearing, and resistant to abrasion, and corrosion.

Optipipe is well suited for pipe applications that demand high abrasion resistance combined with low friction.

*Advantages of **Optipipe** Pipe Over Steel Pipe*

- 40 times the abrasion resistance of steel (ref. Madsen)
- 8 times lighter than steel

- 5 times lower coefficient of friction than steel
- The pressure loss of Optipipe pipe is 1/10 of steel pipes and 1/7 of nylon pipes.
  Benefits

Optipipe pipes offer high wear and abrasion resistance, making them ideal for slurry pipe and dredging pipe. The low friction of Optipipe pipe enables solid particles to slide easily over the surface and avoids scaling and fouling.

The smooth interior surfaces of Optipipe pipes assure low friction loss and high flow rate.

About ***Optipipe***™ Pipe

- Ultra wear resistant
- Ultra low friction
- Ultra smooth
- Ultra tough
- Ultra high molecular weight

Uses of ***Optipipe***™ Pipe

- Dredging Pipe
- Slurry Pipe
- Mineral Sands Pipelines
- Mine tailings Pipelines
- Mine Concentrate Pipelines
- Water and Sewerage Pipelines

When abrasive materials are transported through steel pipe their effect on the inner pipe surface can be very damaging. Abrasive wear within these transportation systems occurs when hard particles are forced against or slide along the wall of the pipe. A loss of wall thickness is the result of the hard, sharp, angular edges producing a cutting or shearing action on the pipe wall. In more extreme cases, these effects can result in pipe leaks or failure, or significant maintenance costs and downtime for pipe replacement. Mild steel pipe is simply not abrasion resistant enough to stand up to the abuse for more than a year or two.

Most abrasion-resistant pipe options operate on the premise that when two objects meet, the harder object' wins'. To deal with this phenomenon, products are available in a variety of hardness, measured on the Brinell Scale, from A-R steel (200 BHN) through iron cast pipe (up to 800 BHN). Unfortunately, any product that is very hard throughout the wall thickness is also extremely brittle. Excessive brittleness is unacceptable, as piping systems are constantly flexing and moving as a result of pressure surges and spikes and due to mechanical and physical contact at a plant.

However, one type of pipe can offer the best of both worlds: recently developed Optipipe pipe exhibits extremely high abrasion resistance combined with good ductility and flexibility. Ultra PE Pipe will typically last two to four times as long as mild steel in high-wear slurry applications.

The pipe can be cut and bent like regular polyethylene pipe and accepts standard end options of flanges, weld rings, and couplings.

Slurry Wear Resistance

TABLE 1 – ***Flow-through slurry wear rates for several materials. Test conditions: 2 weight % silica sand (50/70 mesh) in tap water, impeller velocity 15.7 m/s, temperature range 6 to 17 degrees C***

Material	*Wear Rate mm3/h*	*Hardness HV*	*Carbon Weight %*
1020 steel	23.0	130	0.18
304 stainless steel	22.3	157	0.06
A514 Steel	21.1	284	0.19
316 stainless steel	18.5	151	0.04
5145 steel	15.6	298	0.61
1080 steel	15.2	172	0.78
8740 steel (heat treated)	14.3	585	0.42
4142 steel (heat treated)	10.2	580	0.30
Cobalt-base facing No.1	8.91	438	1.33
4243 steel (heat treated)	7.08	690	0.42
1060 steel (heat treated)	6.11	695	0.59
1080 steel (heat treated)	5.27	789	0.78
Nickel-base hard facing	3.61	585	0.56
Cobalt-base facing No.2	2.43	518	1.15
White cast iron (17Cr)	2.17	655	3.00
Cobalt-base facing No.3	1.37	513	1.18
Optipipe	0.537	N/A	N/A

MADSEN AND BLICKENSDERFER ON FLOW-THROUGH TEST 177

Table 1: *presents the normalised wear rates for 17 materials. The materials represented include steel alloys, hard facings, and Optipipe™. The test conditions, hardness and carbon content are included in the table. The data show a wide range of wear rates among the various materials. Differing by a factor of 43. Among the materials, Type 1020 steel had the highest wear rate, the Optipipe™ had the lowest wear rate, only 2.5% of that of the standard type, A514 steel. For the metallic specimens these illustrated the importance of hardness and carbon content for high wear resistance.*

Wear Resistance Table

Material	Relative loss from Abrasion	Resistance as a 0% of Steel
Optipipe ®	22	454
AR Steel	62	161
304 Stainless	82	122
Carbon Steel	100	100
HDPE	218	-218
PVC	532	-532
6061 Aluminium	1042	-1042

Taber Abrasion Resistance

Tabor Abrasion Comparison (CS17 wheels,1000g load,5000 cycles)
Tabor Abrasion (mg loss/1000 cycles)

Optipipe ™	39
PTFE	45
Nitrile rubber	48
Nylon	50
PEEK	55
Acetal	137
ABS	275
Neoprene rubber	278

Low Coefficient of Friction

Optipipe has a very low coefficient of friction and is self-lubricating. Its coefficient of friction is significantly lower than that of nylon and polyacetal and is comparable to that of PTFE (Teflon), but Optipipe has better abrasion resistance than PTFE (Teflon).

Coefficient of Friction

- Teflon pipe (Static) = 0.04
- Optipipe pipe (Dynamic) = 0.14
- Optipipe pipe (Static) = 0.16
- HDPE pipe (Static) = 0.25
- Steel pipe (Static) = 0.8

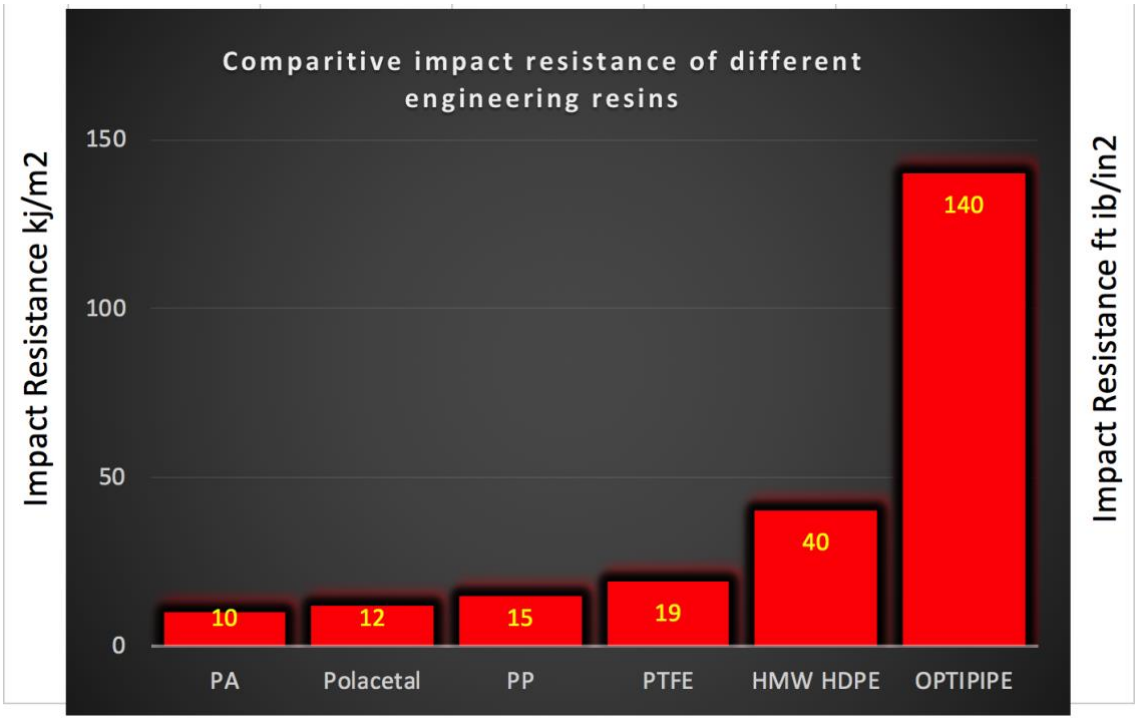
Smooth Bore

Optipipe pipes have smooth interior surfaces which assure low friction loss and high flow rate. Because Optipipe pipe do not rust, pit, scale, or corrode, the high flow rate continues for the life of the piping system.

Pipe Roughness *Optipipe™* pipes have a surface rough (k) value of 0.0010 (compared to other pipes below)

Surface	Absolute Roughness - *k*	
	10^{-3} (m)	*(feet)*
Copper, Lead, Brass, Aluminum (new)	0.001 - 0.002	$3.3 - 6.7\ 10^{-6}$
PVC and Plastic Pipes	0.0015 - 0.007	$0.5 - 2.33\ 10^{-5}$
Epoxy, Vinyl Ester and Isophthalic pipe	0.005	$1.7\ 10^{-5}$
Stainless steel	0.015	$5\ 10^{-5}$
Steel commercial pipe	0.045 - 0.09	$1.5 - 3\ 10^{-4}$
Stretched steel	0.015	$5\ 10^{-5}$
Weld steel	0.045	$1.5\ 10^{-4}$
Galvanized steel	0.15	$5\ 10^{-4}$
Rusted steel (corrosion)	0.15 - 4	$5 - 133\ 10^{-4}$
New cast iron	0.25 - 0.8	$8 - 27\ 10^{-4}$
Worn cast iron	0.8 - 1.5	$2.7 - 5\ 10^{-3}$
Rusty cast iron	1.5 - 2.5	$5 - 8.3\ 10^{-3}$

Mechanical Properties



Optipipe™ pipes are highly resilient, tough and durable products that have high-tensile and high-impact strength. They withstand high pressure for long periods.

Lightweight

Optipipe pipes are lightweight – approximately one-half the weight of aluminium and one-eighth the weight of steel – reducing transportation, handling, and installation costs. They have smooth seamless interior walls.

*Key Benefits of **Optipipe**™ Pipes*

Impact resistance: Optipipe pipes have strong enduring capability to the impacts from various sands, mud and slurries.

Corrosive resistance: With higher structure stability, Optipipe pipes are corrosive resistant to sea waters. No electro chemical corrosion, no need anti-corrosive coating.

The internal roughness of Optipipe pipe is only 0.0010 mm thus the pressure loss of Optipipe pipe is about 1/10 of steel pipes resulting in an over 20% of increase in transfer efficiency.

Since the internal wall of Optipipe pipes is very smooth this practical prevents fouling or scale formation on the inner wall of the pipe and hence there is no drop in pumping efficiency.

Light weight: The density of Optipipe pipe is only 1/8 of steel pipe. It is easy to move and install, especially suitable for the working sites where lifting machines is not available.
Easy connection: flanges are available to connect the pipes, No need washers

Lower Downtime

Optipipe pipes offer: Lower Maintenance Costs, Less Maintenance Downtime.

The superior wear resistance of Optipipe pipe significantly increases the time between pipe replacements and/or rotations leading to large savings by way of reduced maintenance costs and lost production. It therefore lends itself to high wear areas and where redundancy is poor/low.

The low mass allows for ease in hand ability and reduced structural support requirements. Corrosion resistance, whether oxidative or chemical, allows for asset life extension across the life of mine in low wear applications. In gravitational pipes and launders the low friction coefficient reduces the need for large pipe angles and excessive wash water addition throughput.

Reduced Pumping Costs

Optipipe pipes also offer significant cost savings through increased pumping efficiency. Since the inner bore of Optipipe pipes is extremely smooth and self-lubricating (comparable to PTFE (Teflon™).

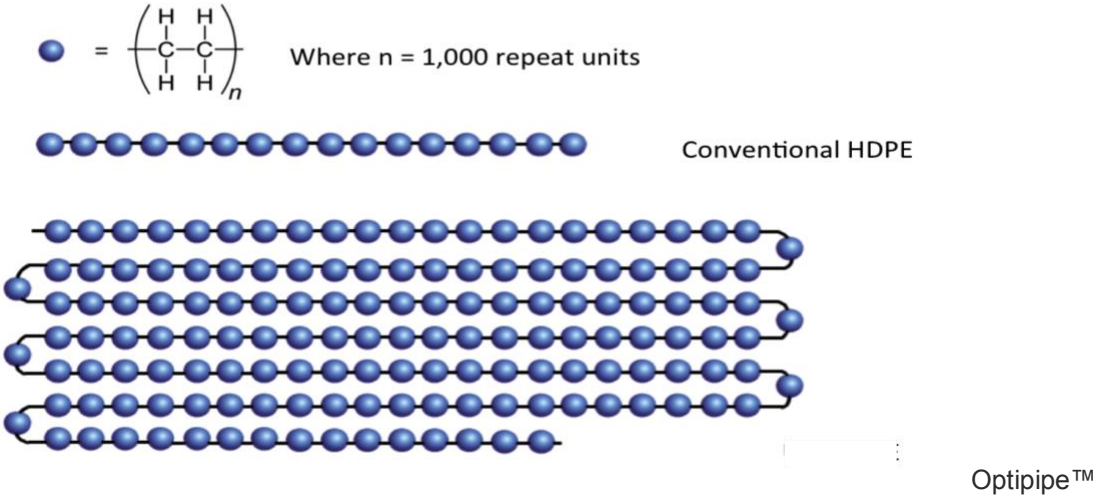
The low coefficient of friction of the pipe surface leads to lower pressure loss and hence reduced energy inputs for pumping slurries.

Role of Optipipe

Optipipe is a polyethylene polymer with an average molecular weight is greater than 3,100,000 as defined by ASTM D4020 – Standard specification for Optipipe polymers. This molecular weight is well above the molecular weight of most typical polymers which are between 1,000,000 and 400,000 thus earning the title of a type of Optipipe. Optipipe's molecular weight is in the 3.1-4.5 Million range have been found to exhibit the best combination of impact strength and abrasion resistance. For Polyethylene molecular weight classification, the following guidelines can be used:

- HDPE (High Density Polyethylene): 100,000 – 400,000 MW
- HMWHDPE (High Molecular Weight High Density Polyethylene) 500,000 – 1,999,999
- VHMWHDPE (Very High Molecular Weight High Density Polyethylene) 2,000,000 – 3,100,000
- **Optipipe™** > 3,100,000 + MW

Molecular Weight



*Attributes of **Optipipe™** Pipes*

- Abrasion resistance – Optipipe pipes have excellent abrasion resistance providing long life in abrasive slurry applications.
- Chemical resistance – outstanding resistance to a wide range of chemical reagents allows the use of Optipipe systems in tailings pipelines and chemical treatment applications used in mining operations.
- Flexibility – Optipipe pipes can be bent to a minimum of 30 times the pipe's outside diameter for HDPE. This flexibility and resiliency allows the pipe to absorb surge pressures, vibration and stresses caused by soil movement. This makes the pipes particularly useful in submarine pipe lines, mine subsidence and earthquake prone areas.
- High flow capacity – low friction compared with materials such as fibre reinforced cement and resistance to material deposit build-up give Optipipe pipes long lived high flow capacity.
- Lower pumping cost due to greater hydraulic capacity as compared with steel and HDPE pipes.
- Ease of installation – Optipipe is easy to install with light weights and flanged couplings.

*Benefits of **Optipipe™***

Optipipe by virtue of its extremely high molecular weight yields several unique properties, including the highest abrasion resistance and highest impact strength of any plastic.

Beware of competitive products claiming to be Optipipe as some techniques for processability of Optipipe are not without an attendant disadvantage since effective amounts of intermediate molecular weight polyethylene causes a marked decrease in some of the most desirable properties of the Optipipe, such as impact strength and abrasion resistance.

The high molecular weight is what gives Optipipe a unique combination of high impact strength, low coefficient of friction and abrasion resistance that outwears carbon steel 10 to 1 making it more suitable for many applications where lower molecular weight grades fail.

Optipipe pipes can be used in a broad range of mining and industrial slurry applications due to its three main characteristics: high impact strength, outstanding abrasion resistance and extremely low coefficient of friction.

Optipipe is a tough, abrasion-resistant thermoplastic with a molecular weight of greater than 3 million. Optipipe pipes have reduced coefficient of friction, improved abrasion resistance, lower wear rates over conventional HDPE pipes such as PE100

Exceptionally High Wear

Optipipe shows unusually high wear resistance compared to most materials. This is due to a combination of very high molecular weight and the resulting entanglements and relative surface softness with a slippery waxy surface.

Bowl of Spaghetti

An easy way to envisage Optipipe is to think of a plate of cooked spaghetti with the long strands all intertwined. If the spaghetti is cut up, it would closely approximate the molecular appearance of regular HDPE. Since very long strands of spaghetti approximating the chains of Optipipe are completely intertwined it would be very difficult to pull them apart. This simplification explains the outstanding abrasion resistance (the difficulty in pulling out particles of the polymer).

Pressure Rating

The nominal diameter of the Optipipe pipes is from 65mm to 800mm, and the wall thickness if from 8mm to 38mm usually. The nominal standard pressure rating of Optipipe™ is from 0.6 MPa to 2.0 MPa with the capability to be manufactured to achieve a rating of 6.4 MPa.

Key Applications

- Optipipe pipe for dredging
- Slurry pipe
- Tailings pipe
- Coal mine pipe
- Wear resistance pipe
- Mud & sand dredging pipe
- Pipe for municipal sewage sludge dredging

Uses

- Mining Industry - Optipipe pipes are used as transportation pipelines for mine slurry, tailings, sediments and ore concentrates.

- Coal power plants – Optipipe pipes are used as pipelines for the transport of coal slurry, fly ash and the fly ash water slurry.

- Dredging Industry – Optipipe pipes are used to transport mud and sand during dredging of rivers, harbours, dams and lagoons.

- Construction Industry - Optipipe pipes are used transporting the slurry of the mixed concretes and shotcretes from pump trucks as well as drilling sand/rocks from underground tunnelling

- Ultra PE abrasion-resistant piping systems are manufactured to meet specific applications for operations moving highly abrasive materials, : Mining – mineral, phosphate and coal mining; feed, waste and debris lines; in-plant piping; tailing lines, backfill; waste disposal; slurry transport; raw ore streams; in-process streams; paste; shotcrete

- Product Conveyance – dilute and dense phase pneumatic movement operations for powder and bulk materials such as cement; coal combustion by products; slurry transport; biomass feedback; glass, frit and plastics; food products.

- Fossil Fuel Power Plants – FGD reagents (wet or dry); pulverized fuel; fly ash; bottom ash; economizer ash; coal combustion by products

- Mills and Foundries – in-plant piping; blow lines; storage; waste disposal; slag; sand lines.

*Examples of Applications of **Optipipe™** Pipe*

- Piping systems for coal-fired power plants for conveying of coal ash slurry to nearby settling ponds, transfer of limestone slurry to absorber spray towers for removal of SO2 and dilute hydrochloric acid from flue gases, and for transporting away the calcium sulphate by-product of the flue gas desulfurization process

- Optipipe pipes can be used for limestone slurry which is used in flue gas desulfurization (FGD) systems, where it reacts with the flue gas thus removing the SO2. In the process, limestone slurry is converted into a calcium sulphate slurry. The waste products are then pumped from the bottom of the FGD spray towers through Optipipe pipe for further treatment.

Wear Resistance

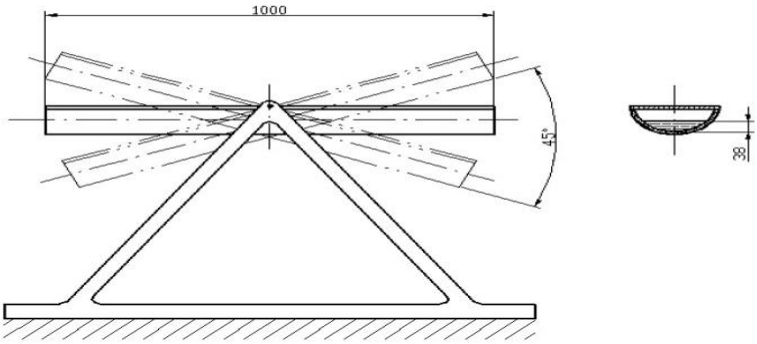


Fig. 1. Schematic diagram of wear resistance testing apparatus according to TH Darmstadt requirements

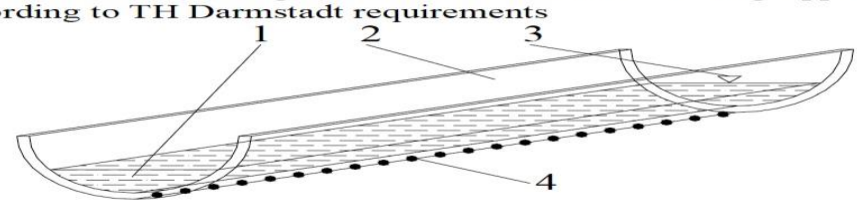
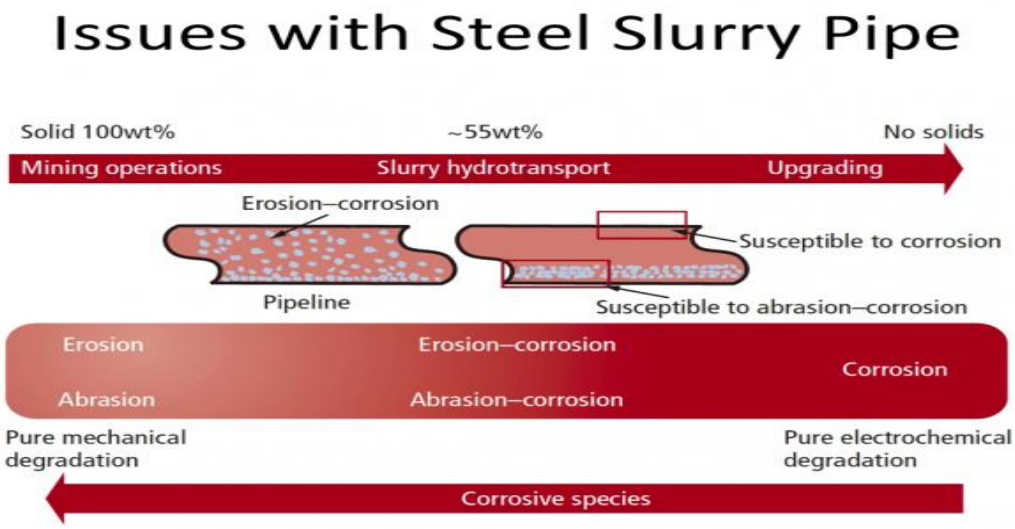


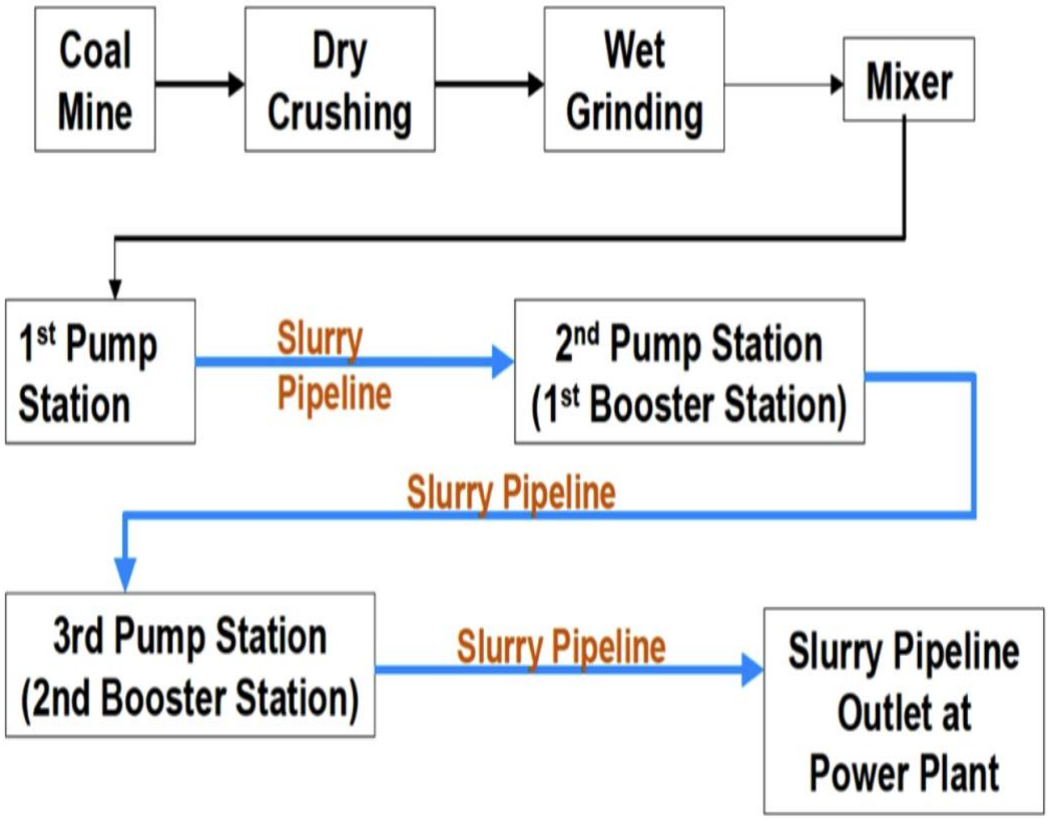
Fig. 2. Test sample: 1 — water with abradant, 2 - test sample, 3 - water level, 4 - wall thickness measuring points

Abrasion Resistance

Of all the pipe materials, Optipipe pipes exhibit the smallest abrasion index. Of all the plastic pipes presently available, the anti-abrasion performance of Optipipe is 18 times higher than phenolic polymers, 6 times higher than polyamide polymers (PA66), 5 times higher than poly(tetrafluoroethylene) (PTFE) as well as being 6.6 times higher than carbon steel, 5.5 times higher than stainless steel and 27 times higher than copper, so Optipipe™ pipes can profoundly increase the service lifespan of slurry pipes.



Optipipe ™ COAL Slurry Pipe



Optipipe ™ Specification Table

Diameter mm ii	0.6Mpa Wall Thickness(mm)	0.8Mpa Wall Thickness(mm)	1.0Mpa Wall Thickness(mm)	1.25Mpa Wall Thickness(mm)	1.6MPa Wall Thickness(mm)	2.0Mpa Wall Thickness(mm)
65					8	9
96					9	10
110					8	10
130				8	10	12
159				10	12	15
168			8	10	13	16
205		8	10	12	15	18
219		9	11	13	16	20
236		10	12	14	18	22
250		10	12	15	19	23
273	9	11	13	16	21	25
280	9	11	14	17	21	26
300	10	12	15	18	23	27
315	10	12	15	19	24	29
325	10	13	16	19	24	30
350	11	14	17	21	26	32
377	12	15	18	22	28	35
400	12	16	19	24	30	36
415	13	16	20	25	31	
426	13	17	20	25	32	
536	16	21	26	23		
560	16	22	27	33		
630	19	25	30	37		
652	20	26	32	38		
710	21	27	34			
800	23	31	38			

Optipipe ™ Properties Comparisons

Optipipe™ and other types of Pipe

Item	Test Method	Unit	Optipipe	HDPE Pipe	P A66 Pipe	PVC Pipe	Steel Pipe
Viscosity-average Molecular Weight	ISO1628-3	10^4g/mol	500-1050	<50	—	—	—
Approx Melting Temperature	ISO11357.3	℃	136	129	255	160	1410
Water Absorption	ISO62-1999	%	<0.01	<0.01	3.8	0.5	—
Coefficient of Linear Thermal Expansion	ISO11359-2	10^{-4}/℃	1.5	1.2	0.8	0.9	0.17
Density	ISO1183-1-2004	g/cm^3	0.935-0.945	>0.940	1.13-1.15	1.4	7.8
(0.45MPa) Heat Deformation Temp at 0.45Mpa	ISO75	℃	85	71	182-224	≥54	1230
Tensile Strength	ISO527	MPa	>39	<25	61	40	550
Yield Strength	ISO527	MPa	≥22	20	—	19	≥245
Tensile Elongation	ISO527	%	≥250	≥350	60-300	60	20
Gap Beam Impact Strength	ISO179	KJ/m^2	No fracture	<27	5.9-10.8	<10	No fracture
Rockwell Hardness	ISO2039-2	R	40	33	85-120	118	45(C)
Friction Coefficient	ISO8295	—	0.05-0.11	0.28	0.37	0.4-0.6	0.58
Mortar Wear Index	—	—	1	10	5	10	7
Scaling	—	—	No Scaling	Slight	Slight	Slight	Heavy
Corrosion Resistance	—	—	Excellent	Common	Common	Common	Bad

Immunity to Galvanic or Electrolytic Attack

Optipipe pipes are immune to galvanic or electrolytic action. They can be used underground, underwater, in the presence of metals, and can be connected to metals.

Flexibility

Flexibility – Optipipe pipes can be bent to a minimum of 30 times the pipe's outside diameter. This flexibility and resiliency allows the pipe to absorb surge pressures, vibration and stresses caused by soil movement. This makes the pipes particularly useful in submarine pipe lines, mine subsidence and earthquake prone areas.

Thermal Properties

Optipipe pipes have lower thermal expansion properties than conventional HDPE pipes

Compatibility Properties

Optipipe pipes are manufactured to Australian Standards and follow streamline flange flow designs to minimise cavitation and vibration issues when adapting to unlike materials.

Chemical Resistance

- Chemical and Corrosion Resistance
- With chemical resistance second only to PTFE (Teflon), Optipipe pipe offers superior life to other pipeline products in chemically aggressive or corrosive applications under most operating conditions
- Optipipe pipes can withstand 80% hydrochloric acid.
- Optipipe is highly resistant to corrosive chemicals, with exception of oxidizing acids.
- Optipipe pipes are inert to attack by a wide variety of strong acids, alkalis, salt solutions, alcohols, and many other chemicals. They are dependable in corrosive applications and impart no tastes or odours to materials carried in them.

Optipipe ™

Chemical Specification Table

Optipipe™ Chemical resistance of dumbbell-type test specimens after 30 days

+, resistant (mechanical properties not appreciably affected); —, not resistant (decrease in yield stress and ultimate tensile strength greater than 20%; X, limited resistance decrease in yield stress and ultimate tensile strength less than 20%

Reagent	Temperature 20 °C (68 °F)	50 °C (120 °F)	80 °C (175 °F)
Inorganic acids			
Chromic acid (80%)	+	+	x
Hydrochloric acid (concentrated)	+	+	+
Hydrocyanic acid	+	+	
Hydrofluoric acid	+	+	
Nitric acid (concentrated)	—	—	—
Nitric acid (50%)	x	—	—
Nitric acid (20%)	+	+	x
Phosphoric acid (85%)	+	+	+
Sulfuric acid (concentrated)	+	—	—
Sulfuric acid (75%)	+	x	x
Sulfuric acid (50%)	+	+	+
Alkalies			
Aqueous ammonia	+	+	
Potassium hydroxide solution	+	+	+
Sodium hydroxide solution	+	+	+
Aqueous solutions of inorganicsalts			
Aluminum chloride	+	+	+
Ammonium nitrate	+	+	+
Bleaching powder	+	+	+
Calcium chloride	+	+	+
Sodium carbonate	+	+	+
Sodium chloride	+	+	+
Sodium hypochlorite	+	+	+
Zinc chloride	+	+	+
Organic acids			
Acetic acid (99%)	+	+	x
Acetic acid (10%)	+	+	+
Butyric acid	+	+	
Citric acid	+	+	+
Formic acid	+	+	
Oleic acid	+	+	x

Reagent	Temperature 20 °C (68 °F)	50 °C (120 °F)	80 °C (175 °F)
Hydrocarbons and halogenated hydrocarbons			
Benzene	x	x	
Carbon tetrachloride	x		
Cyclohexane	+	+	
Dichloroethylene	—	—	
Diesel oil	+	+	x
n-heptane	+	+	
Petroleum ether	+		
Trichloroethylene	x	—	
Toluene	x	—	
White spirit	+	x	
Xylene	x	x	—
Alcohols,ketones, ester and amines			
Acetone	+	+	
Aniline	+	+	x
Benzyl alcohol	+	+	+
Butyl alcohol	+	+	+
Cyclohexanol	+	+	+
Ethanol	+	+	
Ethyl acetate	+	+	
Ethylene glycol	+	+	+
Glycerine	+	+	+
Lauryl alcohol	+	+	+
Propyl alcohol	+	+	+
Miscellaneous			
Beer/Wine	+	+	+
Detergents in aqueous solution	+	+	+
Distilled water	+	+	+
Hydrogen peroxide 30% (perhydrol)	+	+	
Linseed oil/olive oil	+	+	+
Milk	+	+	+
Seawater	+	+	+

Other Capabilities

Optipipe ™

We also manufacture:

- Pipe bends
- Spigots
- Wear plate

Custom orders welcome!

Contact Information

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