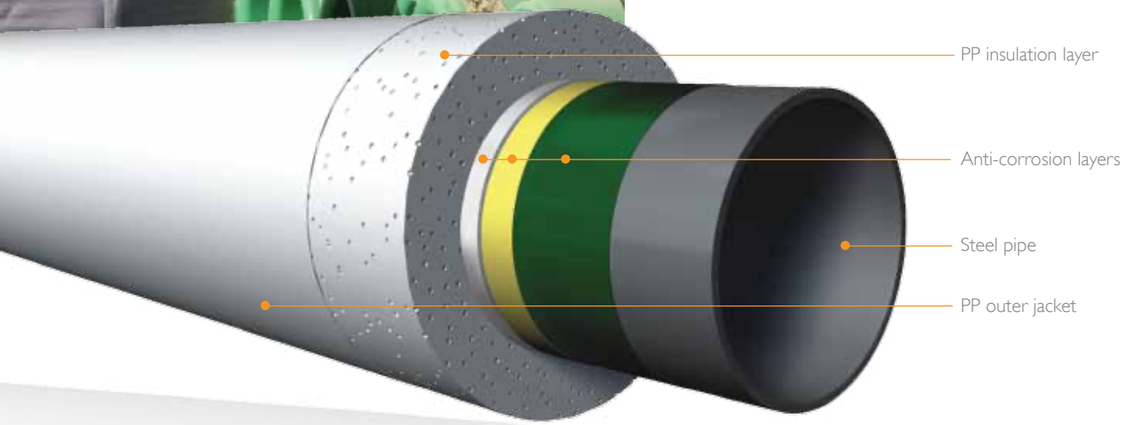

Wetisokote® quality control

Wetisokote®

Five layer polypropylene thermal insulation coating systems.

Through its three alternative insulation systems, Wetisokote® covers all the range of thermal insulation needs for shallow, deep and ultra deep waters. Its Multy-Pass® application technology of lateral extrusion offers the possibility of combining variable thicknesses of different materials as per the specific requirements of each project. Then, and without this setting a limit, this combination of materials enables to reach maximum operation temperatures up to 140 °C in sea depths deeper than 3,000 meters, also adding anti-corrosive protection and mechanical resistance.

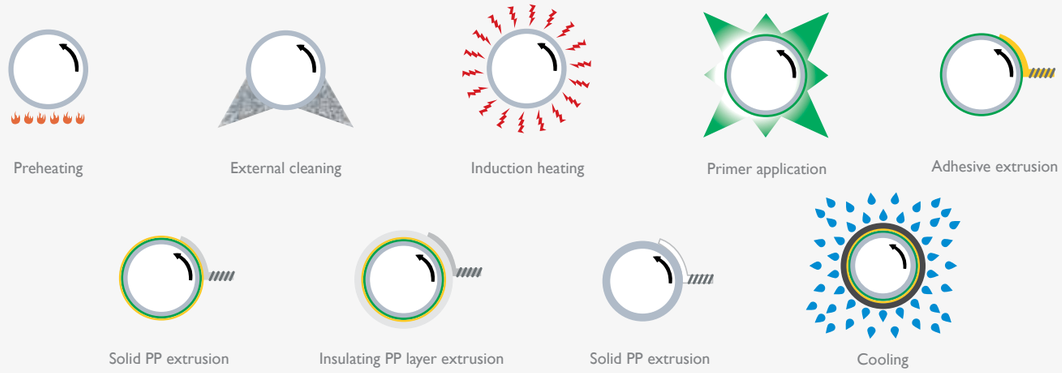


DESCRIPTION AND PRODUCTION PROCESS

Wetisokote® thermal insulation systems can be applied on flowlines, risers, spools and jumpers, regardless of their diameter or set up system (j-lay, s-lay or reeling). Its five layers are applied and work as follows:

	5LPP Foam	5LPP Solid	5LPP Syntactic
RECOMMENDED FOR	Shallow and deep waters (up to 600 m)	Ultra deep waters	Ultra deep waters
LAYER 1	**Fusion Bonded Epoxy Primer.** The first layer is of FBE powder (Fusion Bonded Epoxy) and is applied once the steel pipe outer surface has been blasted. Its purpose is to provide the pipe with a protective film which may resist the attack of chemical agents and may ensure high resistance to cathodic disbondment		
LAYER 2	**Polypropylene Copolymer Adhesive.** The second layer is of an adhesive copolymer which functions as a bonding layer between the FBE powder layer and the third layer.		
LAYER 3	**Solid Polypropylene.** The third layer is of Solid Polypropylene applied by extrusion and ensures the integrity of the anti-corrosive three layer system.		
LAYER 4	**Polypropylene Foam.** The fourth layer is of Polypropylene Foam and it is the one that gives the system the qualities of thermal insulator. This layer thickness depends on the required insulation level as per what each project needs.	**Solid Polypropylene.** The fourth layer is of Solid Polypropylene and it is the one that gives the system the qualities of thermal insulator. This layer thickness depends on the required insulation level as per what each project needs.	**Syntactic Polypropylene.** The fourth is the one that gives the system its properties as a thermal insulator thanks to the introduction of hollow glass microspheres on the Polypropylene matrix. Simultaneously, it also reinforces the whole system hydrostatic pressure resistance. This layer thickness depends on the insulation level as per each project
LAYER 5	**Solid Polypropylene Outer Layer.** The outer layer is a Solid Polypropylene copolymer and offers aging stabilization packaging, mechanical protection and resistance to UV rays and abrasion.		

Application processes



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Five Layer Polypropylene Foam (5LPP Foam)
TECHNICAL DATA

PHYSICAL PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Density	PP Adhesive Solid PP PP Foam	ASTM D 792	g/cm³	0.89 - 0.90 0.89 - 0.90 0.70 - 0.76
Melting Point	PP Adhesive Solid PP PP Foam	ASTM D 1238	°C	≥ 140 ≥ 160 ≥ 160
Cathodic Disbondment @ 48 hours / 90 ± 3 °C / -1.5 V / NaCl (3%)	3LPP	CSA Z 245.21	mm	≤ 3
Cathodic Disbondment @ 28 days / 20 ± 3 °C / -1.5V / NaCl (3%)	3LPP	CSA Z 245.21	mm	≤ 5
Water Absorption (65 °C / 7 days)	Solid PP PP Foam	ASTM D 570	%	≤ 0.5 ≤ 3.0
Tri-axial Creep (53 bar / 90 °C)	Solid PP PP Foam	Internal Procedure	%	≤ 0.5 ≤ 3.0

(1): Typical properties are listed in this document. Should additional properties be required, our Commercial Technical Department is willing to provide them upon request.
(2): Each test is performed in accordance to internal procedures which are based on the standards listed in this column.
(3): These are nominal values. They have not to be considered as specification limits.

MECHANICAL PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Adhesion Resistance	3LPP	DIN 30678 NF A 49-711	N/mm	≥ 20 at 23 °C ≥ 4 at 110 °C
Compressive Strength @ 10 % strain	Solid PP PP Foam	ASTM D 695	MPa	≥ 20 ≥ 10
Tensile Strength at Break @ 23 °C	Solid PP PP Foam	ASTM D 638	MPa	≥ 17 ≥ 5
Elongation at Break @ 23 °C	Solid PP PP Foam	ASTM D 638	%	≥ 400 ≥ 70
Adhesion Between Layers	Solid PP – PP Foam PP Foam – PP Foam	Internal Procedure	MPa	≥ 5 ≥ 5
Abrasion (CS17 Wheel / 1,000 cycles)	Solid PP PP Foam	ASTM D 4060-95	mg	≤ 25 ≤ 75
Indentation	Solid PP	DIN 30678 NF A 49-711	mm	≤ 0.10 at 25 °C ≤ 0.40 at 110 °C
Hardness @ 23 °C	Solid PP PP Foam	ASTM D 2240	Shore D	≥ 60 ≥ 45
Fatigue 0.2 % strain	5LPP Foam	Internal Procedure	Cycles	> 1,000,000
Reeling Test Bend radius: 7.0 m Straightening radius: 31.1 m	5LPP Foam	Internal Procedure	-	No defects
Impact Resistance @ 23 °C	5LPP Foam	DNV-OS-F101	kJ/mm	≥ 12
Shear Test	5LPP Foam	Internal Procedure	MPa	≥ 5
UV Resistance 800 hours	Solid PP (Top coat)	NFA 49711 Annex J.1	%Δ MFI	≤ 35 from original value
Heat Ageing	Solid PP (Top coat)	DIN 30678	%Δ MFI	≤ 35 from original value

INSULATION PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Thermal Conductivity	Solid PP PP Foam	ASTM C 518	W/m.K	0.210 – 0.220 0.165 – 0.175
Specific Heat Capacity	Solid PP PP Foam	ASTM E 1269	J/g.K	> 2.0 > 1.8

TRACK RECORD

Year	Project	Contractor	End Customer	Steel Pipe [mm] OD[1]	Steel Pipe [mm] WT[2]	Length [m]	Thickness [mm]	Max. Temp. [°C]	Installation Method	U-value [W/m2.K][3]
2001	Otter EPIC 2STS	Technip	Total	273.1	15.9	13,000	32.5	80	Reeling	6.10
2003	Yoho EPC2	Eni Saibos	Exxon Mobil	273.1	20.6	12,000	35.3	90	J-Lay	5.70
2004	Benguela Belize	Stolt Offshore	Chevron	273.1	12.7	6,500	25.4	121	J-Lay	8.66
				273.1	18.3	2,000	82.5			3.17
				219.1	15.9	1,000	90.0			3.17
2005	West Espoir	Eni Saibos	CNR International	323.9	12.7	6,000	45.0	90	S-Lay	5.00
2005	Lobito Tomboco	Subsea 7	Chevron	219.1	15.9	19,000	96.0	120	J-Lay	3.17
				273.1	15.9	31,400	89.0			3.17
2006	Brenda & Nicole	Technip	Oilexco	168.3	9.5	19,000	22.0	80	J-Lay	10.80
				273.1	12.7	9,000	20.0			11.20
2007	Ptarmigan & Shelley	Technip	Oilexco	168.3	9.5	10,000	22.0	80	J-Lay	10.80
				273.1	12.7	9,000	20.0			11.12
2008	Tombua Landana	Subsea 7	Chevron	219.1	15.9	9,600	83.0	121	Reeling	3.40
				273.1	18.3	18,900	77.0			3.40
2011	Beta	Helix	Beta Offshore	273.1	15.1	18.000	25.4	90	220	S-Lay 9.1

(1): Outer diameter.
(2): Wall thickness.
(3): Heat transfer coefficient.

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Five Layer Solid Polypropylene (5LPP Solid)
TECHNICAL DATA

PHYSICAL PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Density	PP Adhesive Solid PP	ASTM D 792	g/cm³	0.89 - 0.90 0.89 - 0.90
Melting Point	PP Adhesive Solid PP	ASTM D 1238	°C	≥ 140 ≥ 160
Cathodic Disbondment @ 48 hours / 90 ± 3 °C / -1.5 V / NaCl (3%)	3LPP	CSA Z 245.21	mm	≤ 3
Cathodic Disbondment @ 28 days / 20 ± 3 °C / -1.5V / NaCl (3%)	3LPP	CSA Z 245.21	mm	≤ 5
Water Absorption (250 bar / 120 °C / 125 days)	Solid PP	ASTM D 570	%	≤ 0.5
Tri-axial Creep (250 bar / 120 °C / 125 days)	Solid PP	Internal Procedure	%	≤ 0.5

(1): Typical properties are listed in this document. Should additional properties be required, our Commercial Technical Department is willing to provide them upon request.
(2): Each test is performed in accordance to internal procedures which are based on the standards listed in this column.
(3): These are nominal values. They have not to be considered as specification limits.

MECHANICAL PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Adhesion Resistance	3LPP	DIN 30678 NF A 49-711	N/mm	≥ 20 at 23 °C ≥ 4 at 110 °C
Compressive Strength @ 10 % strain	Solid PP	ASTM D 695	MPa	≥ 20
Tensile Strength at Break @ 23 °C	Solid PP	ASTM D 638	MPa	≥ 17
Elongation at Break @ 23 °C	Solid PP	ASTM D 638	%	≥ 400
Compression Module	Solid PP	ASTM D 695	MPa	Avg. 1,000
Young Module	Solid PP	ASTM D 638	%	Avg. 1,000
Adhesion Between Layers	Solid PP – Solid PP	Internal Procedure	MPa	≥ 5
Abrasion (CS17 Wheel / 1,000 cycles)	Solid PP	ASTM D 4060-95	mg	≤ 25
Indentation	Solid PP	DIN 30678 NF A 49-711	mm	≤ 0.10 at 25 °C ≤ 0.40 at 110 °C
Hardness @ 23 °C	Solid PP	ASTM D 2240	Shore D	≥ 60
Fatigue 0.2 % strain	5LPP Solid	Internal Procedure	Cycles	> 1,000,000
Reeling Test Bend radius: 7.0 m Straightening radius: 31.1 m	5LPP Solid	Internal Procedure	-	No defects
Impact Resistance @ 23 °C	5LPP Solid	DNV-OS-F101	kJ/mm	≥ 12
Shear Test	5LPP Solid	Internal Procedure	MPa	≥ 5
UV Resistance 800 hours	Solid PP (Top coat)	NFA 49711 Annex J.1	%Δ MFI	≤ 35 from original value
Heat Ageing	Solid PP (Top coat)	DIN 30678	%Δ MFI	≤ 35 from original value

INSULATION PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Thermal Conductivity	Solid PP	ASTM C 518	W/m.K	0.210 – 0.220
Specific Heat Capacity	Solid PP	ASTM E 1269	J/g.K	> 2.0

TRACK RECORD

Year	Project	Contractor	End Customer	Steel Pipe [mm] OD[1]	Steel Pipe [mm] WT[2]	Length [m]	Thickness [mm]	Max. Temp. [°C]	Installation Method	U-value [W/m2.K][3]
2001	Roncador P-52	DSND	Petrobras	177.8	14.3	32,000	60	110	N/A	4.8
2003	PDET	Technip	Petrobras	457.2	15.9 28.6	62,800	52	N/A	N/A	5.2

(1): Outer diameter.
(2): Wall thickness.
(3): Heat transfer coefficient.

Wetisokote®

Five Layer Syntactic Polypropylene (5LPP Syntactic)
TECHNICAL DATA

PHYSICAL PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Density	PP Adhesive	ASTM D 792	g/cm³	0.89 - 0.90
	Solid PP			0.89 - 0.90
	PP Syntactic			0.64 - 0.68
Melting Point	PP Adhesive	ASTM D 1238	°C	≥ 140
	Solid PP			≥ 160
	PP Syntactic			≥ 150
Cathodic Disbondment @ 48 hours / 90 ± 3 °C / -1.5 V / NaCl (3%)	3LPP	CSA Z 245.21	mm	≤ 3
Cathodic Disbondment @ 28 days / 20 ± 3 °C / -1.5V / NaCl (3%)	3LPP	CSA Z 245.21	mm	≤ 5
Water Absorption (250 bar, 120 °C / 125 days)	Solid PP	ASTM D 570	%	≤ 0.5
	PP Syntactic			≤ 2.0
Tri-axial Creep (250 bar, 120 °C / 125 days)	Solid PP	Internal Procedure	%	≤ 0.5
	PP Syntactic			≤ 3.0

(1): Typical properties are listed in this document. Should additional properties be required, our Commercial Technical Department is willing to provide them upon request.
(2): Each test is performed in accordance to internal procedures which are based on the standards listed in this column.
(3): These are nominal values. They have not to be considered as specification limits.

MECHANICAL PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Adhesion Resistance	3LPP	DIN 30678	N/mm	≥ 20 at 23 °C
		NF A 49-711		≥ 4 at 110 °C
Compressive Strength @ 10 % strain	Solid PP	ASTM D 695	MPa	≥ 20
	PP Syntactic			≥ 12
Tensile Strength at Break @ 23 °C	Solid PP	ASTM D 638	MPa	≥ 17
	PP Syntactic			≥ 5
Elongation at Break @ 23 °C	Solid PP	ASTM D 638	%	≥ 400
	PP Syntactic			≥ 80
Compression Module	Solid PP	ASTM D 695	MPa	Avg. 1,000
	PP Syntactic			Avg. 750
Young Module	Solid PP	ASTM D 638	%	Avg. 1,000
	PP Syntactic			Avg. 900
Adhesion Between Layers	Solid PP– PP Syntactic	Internal Procedure	MPa	≥ 5
	PP Syntactic–PP Syntactic			≥ 5
Abrasion (CS17 Wheel / 1,000 cycles)	Solid PP	ASTM D 4060-95	mg	≤ 25
	PP Syntactic			≤ 75
Indentation	Solid PP	DIN 30678	mm	≤ 0.10 at 25 °C
		NF A 49-711		≤ 0.40 at 110 °C
Hardness @ 23 °C	Solid PP	ASTM D 2240	Shore D	≥ 60
	PP Syntactic			≥ 50
Fatigue 0.2 % strain	5LPP Syntactic	Internal Procedure	Cycles	> 1,000,000
Reeling Test Bend radius: 7.0 m Straightening radius: 31.1 m	5LPP Syntactic	Internal Procedure	-	No defects
Impact Resistance @ 23 °C	5LPP Syntactic	DNV-OS-F101	kJ/mm	≥ 12
Shear Test	5LPP Syntactic	Internal Procedure	MPa	≥ 5
UV Resistance 800 hours	Solid PP (Top coat)	NFA 49711 Annex J.1	% Δ MFI	≤ 35 from original value
Heat Ageing	Solid PP (Top coat)	DIN 30678	% Δ MFI	≤ 35 from original value

INSULATION PROPERTIES

Typical Properties[1]	Layer	Standard[2]	Unit	Value[3]
Thermal Conductivity	Solid PP	ASTM C 518	W/m.K	0.21 – 0.22
	PP Syntactic			0.15 – 0.16
Specific Heat Capacity	Solid PP	ASTM E 1269	J/g.K	1.8 – 2.4 (60°C - 80°C)
	PP Syntactic			1.6 – 2.2 (60°C - 80°C)

TRACK RECORD

Year	Project	Contractor	End Customer	Steel Pipe [mm] OD[1]	Steel Pipe [mm] WT[2]	Length [m]	Thickness [mm]	Max.Temp. [°C]	Installation Method	U-value [W/m2.K][3]
2003/	Bonga	Stolt Offshore	Shell	273.10	25.40	5,000	102.0	95	J-Lay	2.20
2004				323.90	28.60	11,000	88.0			2.40
2005	Erha	Stolt Offshore	Exxon Mobil	273.10	20.60	12,000	94.3	125	J-Lay	3.00
				168.30	15.90	5,000	98.3			3.50
2006	Erha North	Stolt Offshore	Exxon Mobil	273.10	20.60	12,000	94.3	125	J-Lay	3.00
				168.30	15.90	8,000	98.3			3.50
2005/	Greater Plutonio	Stolt Offshore	BP	323.90	20.60	23,000	90.5	90	J-Lay	2.50
2006				323.90	19.10	19,700	91.5			2.50
2006	Deimos	J. Ray Mc Dermont	Shell	219.10	38.40	1,700	60.0	121	J-Lay	5.30
				219.10	30.70	6,800	61.0			4.70
2007	Akpo	Eni Saibos	Total	273.10	27.00	45,000	104.0	120	J-Lay	2.50
2007	Saxi Batuque	Subsea 7	Exxon Mobil	219.10	19.10	14,900	76.0	105	Reeling	3.50
				219.10	25.40	13,000	63.0			4.00
2008	Thunderhawk	J. Ray Mc Dermont	Murphy	219.10	31.75	7,000	81.0	121	Reeling	3.80
				219.10	25.40	13,000	81.0			3.51
2008	Fastball	Helix	Eni	168.30	14.27	17,300	47.0	< 110	Reeling	5.41
2008	Green Canyon	Helix	Eni	141.30	10.90	15,400	40.0	< 110	Reeling	6.18
2008/	Cascade & Chinook	Technip	Petrobras	244.50	25.27	11,000	86.0	> 110	Reeling	3.17
2009				244.50	33.57	10,000	63.0			4.53
2008/9	Perdido	N/A	Shell	358.80	21.59	13,000	102.0	90	Spar	2.02
2009	Pazflor	Technip	Total	282.20	14.10	19,500	48.0	70	Reeling	4.52
2009/	Kizomba Satellites	Saipem	Exxon Mobil	406.40	22.20	2,424	77.0	90	J-Lay	2.81
2010				273.10	20.60	924	125.0			2.50
2010	Galapagos	Technip	BP	219.10	33.00	6,575	85.0	115	Reeling	3.97
2010	MC 252 Phase 1	N/A	BP	350,5		3,500	75,0	90	TTR	3,1
2011	Pyrenees	Ocean Flow International	Newfield	168,3	21,9	26,000	50,4	90	Reeling	5,73
2011	Caesar Tonga	JP Kenny	Anadarko	195,3	34.6	6,000	74.0	90	Reeling	4.64

(1): Outer diameter.
(2): Wall thickness.
(3): Heat transfer coefficient.