

TENCATE **PERFORMANCE COMPOSITES**

Advanced Composites Selector Guide for Oil & Gas

Product Selection Guide
Oil & Gas

Thermoset Composites - Thermoplastic Composites - Thermoplastic Molded Parts - Bulk Molding Compounds



TenCate Advanced Composites

Company Profile



TenCate

TenCate is a leading supplier of specialty materials including ballistic armor, advanced composites, protective fabrics and geosynthetics. TenCate is also one of the leading developers and suppliers of industrial composites for oil and gas, automotive and energy applications.

TenCate Advanced Composites

TenCate offers a wide range of product solutions, including:

- Thermoset advanced composite materials
- Tooling prepregs
- Thermoplastic advanced composite materials
- Bulk composite molding compounds
- Compression molding capabilities for part fabrication
- Film adhesives and syntactics
- Honeycomb services

Whatever your composite material needs are, TenCate has the right solution at the lowest total cost.

Customers turn to TenCate to realize the many benefits that advanced composites offer:

- Weight reduction
- High strength and stiffness
- Corrosion resistance
- Excellent toughness and fatigue resistance
- Ease of fabrication via common molding processes
- Ability to optimize strength and stiffness
- Low flame, smoke and toxicity performance



Energy

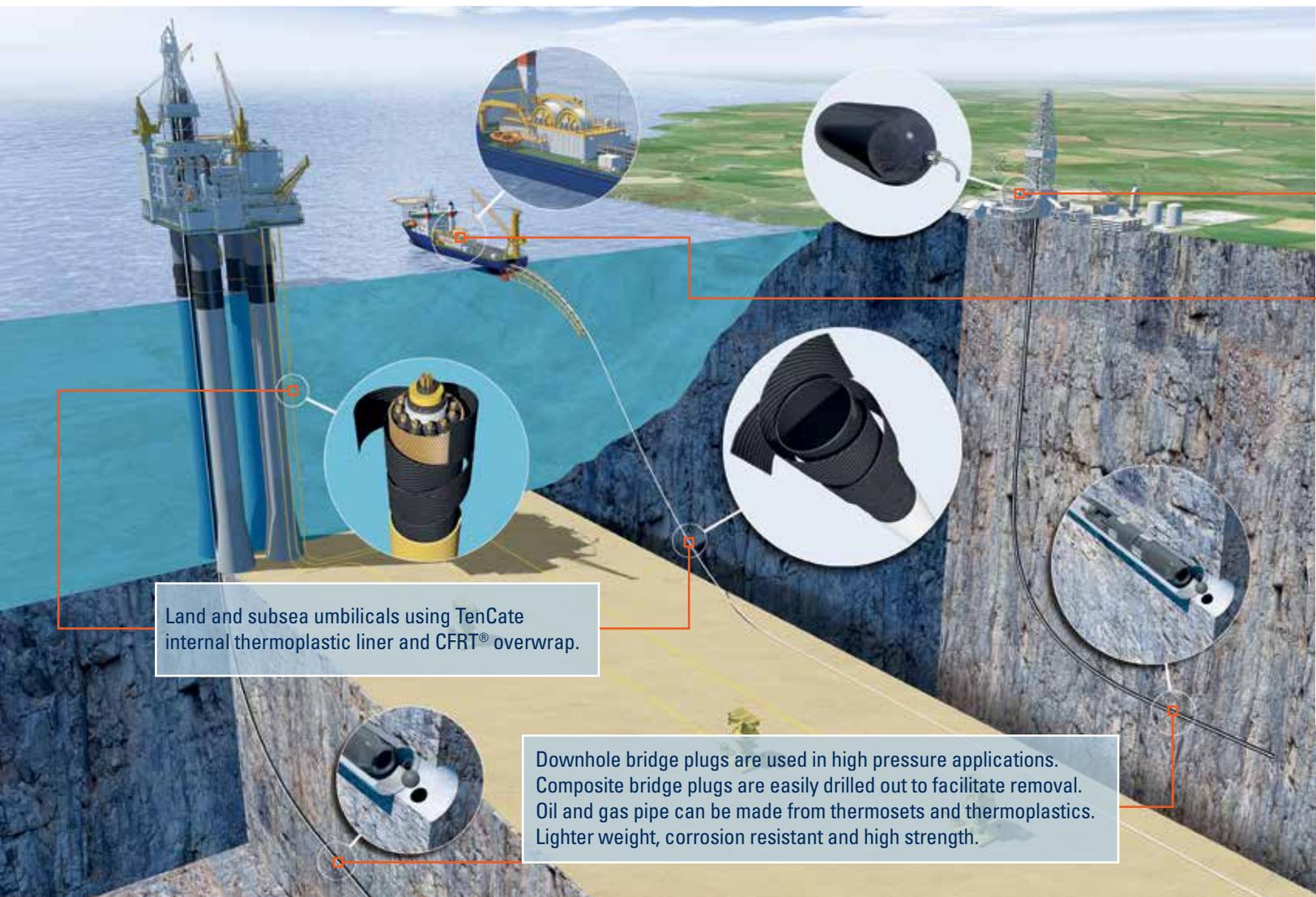
Reduction of downtime and improving cycle time are critical in an industry where every minute counts. The use of corrosion resistant composite materials help reduce downtime and repair costs. Rapid assembly methods, spoolable pipe, and use of lighter structures reduce the infrastructure costs associated with pipeline component replacement. Lighterweight materials also create a safer work environment.

TenCate's products offer the combination of improved corrosion resistance, high strength and stiffness in a lighter weight.

Some oil and gas applications include:

- Wrapped pipe and tubing for increased strength, weight reduction and corrosion resistance
- Molded frac spheres
- Electrically pure dielectric structure and enclosures for down hole inspection and monitoring
- Carbon fiber reinforced tethers
- Composite pressure cylinders
- Bridge plugs





Thermoplastic Materials Selection Guide: **Product Chart**

Product Name	Thermoplastic Resin	Process Temp.	Neat Resin Heat Distortion under Load 1.8 MPa/ 265 psi	Applications
Performance Thermoplastics				
TenCate Cetex® TC910	Nylon 6 (PA6)	480-520°F/ 249-271°C	392°F/200°C	<ul style="list-style-type: none"> Automotive and recreational applications as a result of temperature resistance, toughness and solvent resistance
TenCate Cetex® TC930	High Density Polyethylene (HDPE)	360-390°F/ 182-199°C	253°F/123°C	<ul style="list-style-type: none"> Oil and gas applications such as pipe overwrapping as a result of its strength and toughness
TenCate Cetex® TC940	Polyethylene Terephthalate (PET)	509°F/265°C	392°F/200°C	<ul style="list-style-type: none"> Excellent for recreational and low cost applications for its good impact resistance
TenCate Cetex TC960	Polypropylene (PP)	390-420°F/ 199-216°C	318°F/159°C	<ul style="list-style-type: none"> Used in applications where low cost and high toughness desired (vehicles)
Engineering Thermoplastics				
TenCate Cetex® TC1100	Poly-phenyl-sulfide (PPS)	536°F/280°C	230°F/110°C	<ul style="list-style-type: none"> Ideal for structural applications under 200°F/93°C service temperature Very resistant to solvents
TenCate Cetex® TC1200 & TC1220	Poly-ether-ether-ketone (PEEK)	649°F/343°C	300°F/149°C	<ul style="list-style-type: none"> Very high strength, used in oil and gas and structural applications Good heat resistance to 250°F/121°C and above depending upon load

*For further information on TenCate's line of thermoplastic composite materials, please refer to the TenCate Cetex® and CFRT® Thermoplastic Composite Brochures.

Carbon fiber overwraps of compressed natural gas tanks using prepreg tapes reduce the weight of the tank while increasing its strength. Compressed gas tanks are used to hold a variety of gases often used for fast opening or closing of valves. TenCate offers a variety of thermoset prepreps for this application ranging from epoxy to BMI's for high temperature applications.

Fiber-reinforced spoolable thermoplastic composite pipe for umbilicals. This pipe consists of a liner reinforced with carbon or glass fiber using either TenCate Cetex® TC930 polyethylene (PE) or TenCate Cetex® TC1200 polyetheretherketone (PEEK) unitapes. The pipe has longitudinal reinforcement, creating a pipe with high tensile strength and allowing for sufficient spoolability without fatigue.



Thermoset Materials Selection Guide: **Product Chart**

Product Name	Resin Type	Tg	Cure Temp/Cure Time	Description
Low to Moderate Service Temperature Thermoset Prepreps				
BT250E-1	Epoxy	257°F/125°C	60 minutes at 250°F/121°C	<ul style="list-style-type: none"> • Excellent overall system with moderate toughness for impact resistance
TC275-1	Epoxy	327°F/164°C or 362°F/ 183°C with post cure	360 minutes at 275°F/135°C, or 120 minutes at 350°F/177°C	<ul style="list-style-type: none"> • Designed for thick parts under low cure pressures • Low void laminates • Compatible adhesive TC263 for bonding core or parts to laminate
High Service Temperature Thermoset				
EX-1522	Epoxy	396°F/202°C	120 minutes at 350°F/177°C	<ul style="list-style-type: none"> • Toughened • Low moisture absorption
RS-8HT	BMI	471°F/244°C	120 minutes at 400°F/204°C, followed by post cure of 360 minutes at 450°F/230°C	<ul style="list-style-type: none"> • Thermal stability under high temperatures • Moderate toughness with good moisture resistance • Available in RTM resin form
TC350-1	Epoxy	397°F/230°C	120 minutes at 350°F/177°C	<ul style="list-style-type: none"> • Excellent laminate quality with low pressure cures • Good temperature performance with excellent toughness • Very long work life, 30 days tack life and 45 days for tool life
TC420	Cyanate Ester	350°F/177°C or 610°F/ 321°C with post cure	180 minutes at 350°F/177°C <i>Optional post cure of 500°F/ 260°C for higher Tg</i>	<ul style="list-style-type: none"> • TenCate's highest temperature cyanate ester • Processes like an epoxy yet yields a Tg and performance of a BMI • Excellent thermal stability, good resistance to microcracking

Lightweight Composites

Design, Part and Fabrication Services



TenCate's CCS Composites is a recognized leader in the design and production of high performance compression molded composite parts. CCS Composites specializes in designing and producing parts that benefit the most from the properties of molding compounds, with a particular expertise on extremely high tolerance, geometrically complex parts.

Compression molding is a common alternative for complex structures typically made of aluminium or titanium. Typical reinforcements include carbon and glass chopped fiber, but other reinforcements are possible.



Materials Selection Guide: Bulk Molding Compounds

Compression molding is a highly controlled process using precise resin infused fiber reinforced tape made with standard, intermediate or high modulus fibers. Resins can be thermoset (BMI, cyanate ester, epoxy, etc.) or a thermoplastic (PEEK, PPS, PEI or Nylon) resin. Bulk molding compounds are made by chopping these unitapes into fiber lengths ranging from 1/2" to 1" (12 to 25 mm). Longer fiber lengths generally provide higher strengths, while smaller length fibers allow more complex structural details to be molded into the part.

Product Name	Resin Type	Tg	Description	Resin Properties
Bulk Molding Compounds				
MS-1A	Epoxy	327°F/164°C	High modulus epoxy	Tensile Strength - 42 ksi (290 MPa) Tensile Modulus - 19 Msi (131 GPa)
MS-1H	Epoxy	375°F/191°C	Fast cure intermediate modulus epoxy	Tensile Strength - 37 ksi (255 MPa) Tensile Modulus - 10 Msi (69 GPa)
MS-4H	Epoxy	375°F/191°C	Fast cure standard modulus epoxy	Tensile Strength - 44 ksi (303 MPa) Tensile Modulus - 6 Msi (41 GPa)
TenCate Cetex® MC1100	PPS	194°F/90°C	Thermoplastic based with standard or IM fibers	Tensile Strength - 28 ksi (193 MPa) Tensile Modulus - 5.9 Msi (40.4 GPa)
TenCate Cetex® MC1200	PEEK	290°F/143°C	Thermoplastic based with standard or IM fibers	Tensile Strength - 42 ksi (289 MPa) Tensile Modulus - 6.3 Msi (43.4 GPa)
Various	Thermoplastic	Various	Standard or intermediate modulus	Various

Performance Composites Products

Material Comparisons and Common Composite Fabrics



Material vs Reinforcements	Filament Count	Tensile Strength	Tensile Modulus	Density g/cc
Steel	n/a	58 ksi (400 MPa)	29 Msi (200 GPa)	7.8
Aluminum	n/a	70 ksi (483 MPa)	10 Msi (69 GPa)	2.8
E- Glass	n/a	290 ksi (2,000 MPa)	10.5 Msi (72 GPa)	2.6
S- Glass	n/a	680 ksi (4,689 MPa)	12.5 Msi (86 GPa)	2.5
Standard Modulus Carbon	12K (also 18K, 24K, 48K)	500-700 ksi (3,447-4,826 MPa)	~30-34 Msi (207-234 GPa)	1.8
Intermediate Modulus Carbon	12K	~800 ksi (~5,516 MPa)	~40 Msi (276 GPa)	1.9
High Modulus Carbon	6K, 12K	~575 ksi (~3,965 MPa)	~60-80 Msi (414-552 GPa)	1.9
Ultra High Modulus Carbon	1K, 3K, 12K	~500 ksi (~3,447 MPa)	~115 Msi (793 GPa)	2.2

Table of Standard Weave Styles for Fabrics		Areal Weight (oz/yd2 / gsm)	Description
E-Glass	120 (4 harness satin)	3.14/106	Lightweight glass fabric
	7781 (8 harness satin)	8.87/301	Drapable 8 harness fabric
S-Glass	6781	8.94/303	High strength drapable 8 harness fabric
Ceramic	Plain Weave or 5 harness	7.2-24/244-814	Ceramic-based woven fabrics
Carbon	Plain Weave - 3k	5.7/193	Good fabric stability, but less drapable
	2 x 2 Twill	6.0/205	More drapability than pw, more stable
	5 harness	8.3/281	Good drapability
	8 harness	10.8/366	Excellent drapability

TENCATE ADVANCED COMPOSITES TENCATE PERFORMANCE COMPOSITES

TENCATE PERFORMANCE COMPOSITES, CANADA

5035 N. Service Road, Bldg. A-1
Burlington, Ont., Canada L7L 5V2
Tel: +1 905 332 0991
Fax: +1 905 332 0433

TENCATE PERFORMANCE COMPOSITES, USA

1150 Calle Suerte
Camarillo, CA 93012 USA
Tel: +1 805 482 1722
Fax: +1 805 482 8776

TENCATE ADVANCED COMPOSITES, UK

Amber Drive, Langley Mill
Nottingham, NG16 4BE UK
Tel: +44 (0)1773 530899
Fax: +44 (0)1773 768687

TENCATE ADVANCED COMPOSITES, USA

18410 Butterfield Blvd.
Morgan Hill, CA 95037 USA
Tel: +1 408 776 0700
Fax: +1 408 776 0107

TENCATE ADVANCED COMPOSITES, NL

G. van der Muelenweg 2
7743 RE Nijverdal NL
Tel: +31 548 633 933
Fax: +31 548 633 299

TENCATE ADVANCED COMPOSITES, USA

CCS Composites, LLC
2450 Cordelia Road
Fairfield, CA 94534 USA
Tel: +1 707 359 3400
Fax: +1 707 359 3495

www.tencate.com
www.tencate.com/advancedcomposites

E-mail: info@tcac-usa.com (USA)
E-mail: tcacsales@tencate.com (Europe)
ISO 9001 / AS 9100 Registered

For more information about Oil & Gas, please visit
us online and download our latest literatures:

WWW.TENCATE.COM/Energy

iPad / iPhone / Android Apps



TENCATE
materials that make a difference