



DuPont™ Kevlar®
INNOVATIVE PERFORMANCE SOLUTIONS

Advanced materials for the oil & gas industry



Kevlar®



Use of DuPont™ Kevlar® brand fiber in thermoplastic umbilicals protects and enhances vital functions that control and service undersea drilling and recovery.

Innovative materials; innovative solutions

High-tech products and materials made by DuPont are used by virtually every industry in every part of the world to increase performance, productivity and safety. In oil and gas, DuPont technology is helping set new standards in extraction, pipeline performance, extreme weather operations, and workforce protection.

DuPont™ Kevlar® is an advanced technology meeting a range of industry needs. It is a para-aramid fiber that is five times stronger than steel at equal weight. It is flexible, does not corrode, is heat-resistant and impervious to water, oil and most chemicals. These qualities, together with its high impact strength and fatigue resistance, enables Kevlar® to outperform steel and other materials in many oil and gas pipeline applications.



Connecting the undersea world

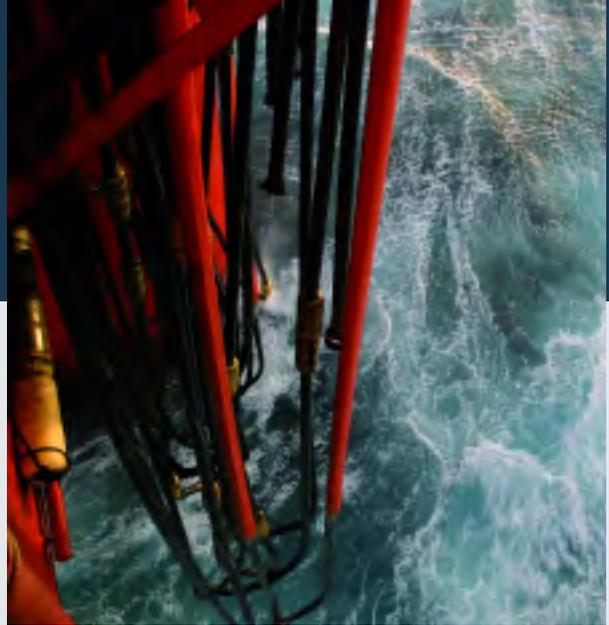
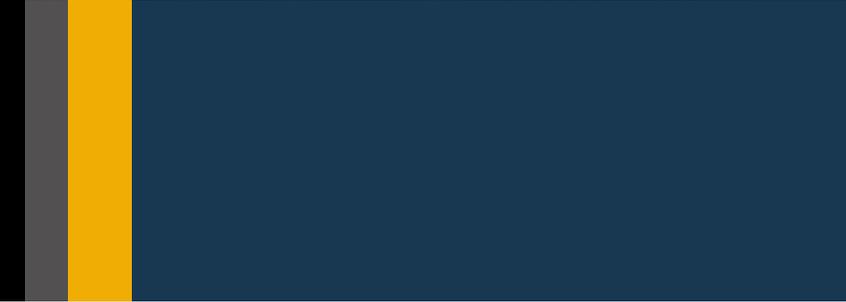
THERMOPLASTIC UMBILICALS

Offshore rigs are the visible tip of a complex network of extraction technology reaching down and outwards across the sea bed far below. Kevlar® brand fiber is widely used in the construction of reinforced thermoplastic umbilicals. These composite structures carry the high pressure hydraulic hoses and electrical or optical cables that remotely control undersea processes and support their servicing.

Kevlar® has been helping to ensure the operational reliability of umbilicals since the mid 1970s. It is currently used in control systems around the world whose exceptional performance and durability are due to its inherent properties: high strength, low elongation and chemical and fatigue resistance.

Computer modeling techniques are used to design the single or multiple reinforcement layers made of Kevlar® that maintain the structural integrity of umbilicals. They can be produced in long continuous lengths. Once laid, they require minimum maintenance even in the toughest conditions.

DuPont and its partners are working closely with oil and gas customers to design and develop umbilicals that will withstand higher operating pressures and wider temperature ranges, improve impact and impulse-fatigue resistance and generally increase their operating capabilities.



FLEXIBLE RISERS

Risers that bring undersea oil to the surface must be strong enough to resist water pressure at drilling depths and the action of turbulent surface conditions on the rigs and vessels they attach to.

Compared to most rigid steel structures, flexible risers reinforced with Kevlar® fiber are light and easy to handle. They can be spooled for transportation and storage in environments where weight and space must be carefully managed.

Risers protected with Kevlar® can be laid quickly – at up to 500 meters an hour – with all connections made on deck. No welding is necessary and the need for intermediate structures is eliminated. Rig weight balancing is also made easier.

Yet there is absolutely no compromise on strength: anti-bird caging (ABC) tape made with Kevlar®TM helps to prevent lateral buckling and maintains the structural integrity of pipelines under external pressure.

Rapid installation, long life and minimum maintenance requirements significantly improve operating costs. Flexible risers are corrosion resistant, do not deteriorate in terms of flow performance, and can be recovered and reused as production needs change.





FLEXIBLE LINES

Flexible constructions reinforced with Kevlar® are used for choke and kill lines, rotary and vibrator lines and test lines. Like risers, these critical components of well control systems are designed to handle high pressures and flow rates. The inherent qualities of Kevlar® brand fiber – superior strength and flexibility, crush resistance and resistance to contraction or elongation – allow trouble-free operation and minimum maintenance needs.

INNOVATIVE SAFETY

Danger is ever present on offshore rigs. The weather, equipment breakage, risk of fire and explosion, personnel movement, supply failures and their inherent isolation combine to create a uniquely hazardous environment. Equipment must be of the highest quality and reliability. Often there is no second chance. Kevlar® is already specified for the undersea and surface ropes and cables, but numerous ideas for innovative applications are at various stages of development. These include: deck and mud mats, lightweight honeycomb composites structures for use in platform accommodation modules and helicopter landing platforms, safe refuge and blast curtains. If things do go wrong, count on the strength and performance of Kevlar® in critical life saving applications, such as protective apparel and escape chutes!



Rapid and safe evacuation of oil platforms is assured by escape chutes made of Kevlar® fibre. The chute is light, quickly deployed and corrosion, chemical and flame resistant.

Onshore challenges



REINFORCED THERMOPLASTIC PIPES

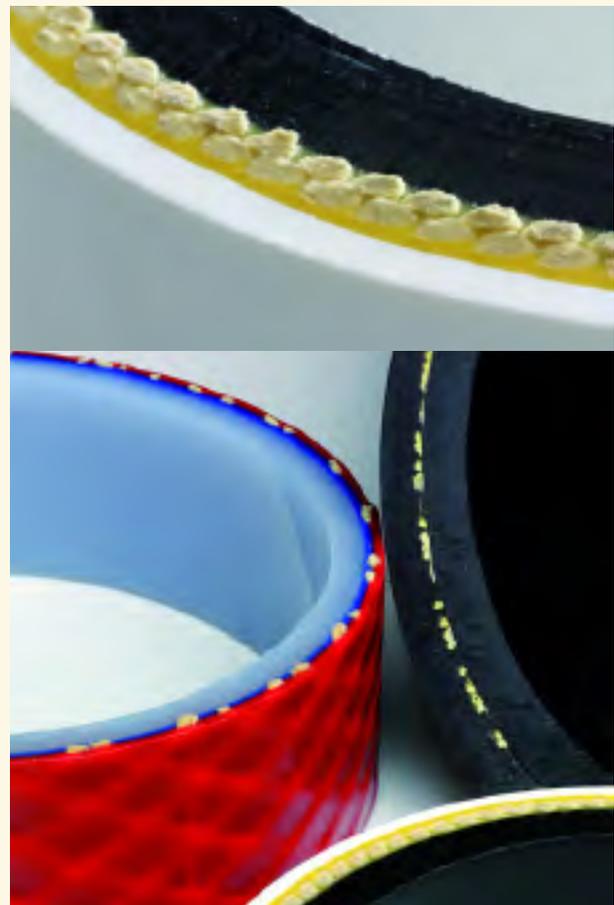
Reinforced Thermoplastic Pipes (RTP) based on Kevlar® brand fiber offer significant performance and handling advantages compared to steel. RTP pipes with Kevlar® are stronger but weigh less. They are flexible and can be spooled in lengths of up to 500 meters for transportation to remote places by relatively light vehicles, thus minimizing road building needs.

Installation above or below ground is quicker because there are fewer connections and the need for prefabricated bends is eliminated. Furthermore, there is no need to dig a ditch for buried installations as it can be trenched into place. Typically, the length of RTP pipeline laid in one day would take seven days or more to achieve working with steel. Installation costs and lead time to production are radically reduced.

There's a significant benefit for the environment too. Once laid, RTP pipelines are leak proof and corrosion free,

requiring minimum maintenance and guaranteeing long life. Lengths are easy to lift and reuse when production and transportation needs change.

DuPont™ Pipelon®, a high performance line of engineering polymer resins, addresses market need for improved permeation resistance and high temperature liner performance.



PUTTING NEW LIFE INTO OLD PIPES

The developed world is criss-crossed with pipeline networks and many are close to the limit of their working life. Energy suppliers, industry and public utilities face spiraling costs of replacing corroding steel. Conventional methods of repair or replacement are expensive, disrupt supply and surrounding infrastructure, especially in urban areas. Innovative use of Kevlar® brand fiber however enables the trenchless renovation of many different kinds of pipeline in a fraction of the time necessary for conventional repair or replacement. Downtime and disruption are minimized. Cost savings can be enormous.

Kevlar® offers tomorrow's solution to the limitations of yesterday's technology: flexible, high-pressure plastic pipes that restore the efficiency of aging pipe networks. In effect, a new pipeline is inserted within the structure of the old. Its tough, flexible construction enables it to be fed around bends and through long lengths up to 2000 metres.

Pipeline diameter is virtually unchanged so there is no loss of volumetric flow. The inner liner is entirely self-contained - the old pipe is only used as a route, so continuing deterioration is irrelevant.





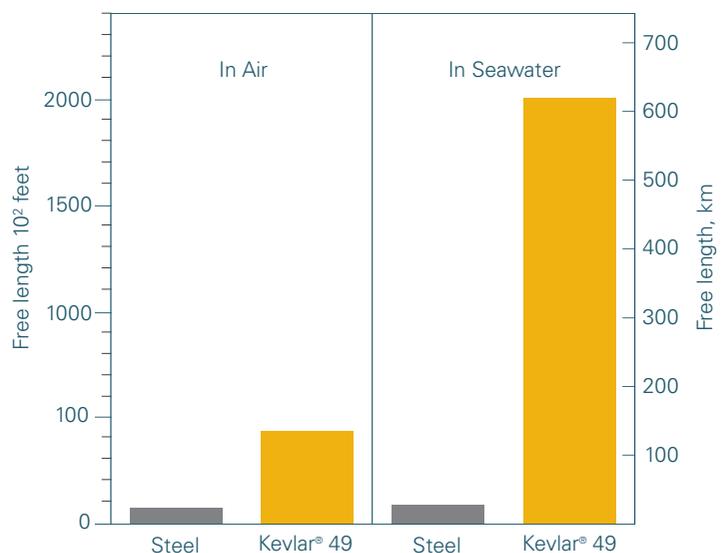
The Kevlar® brand fiber in figures

DuPont scientists and product development engineers work closely with their partners and customers in the oil and gas industry to exploit the versatility and advantageous product characteristics of DuPont™ Kevlar® in new and different ways.

The strength, weight and performance characteristics of Kevlar® are inherently suited to a very wide range of applications. All Kevlar® yarns have excellent chemical resistance. They have good thermal stability and do not support combustion.

Long term use at temperatures of up to 160° C will not cause significant degradation and short term exposure of up to 300° C can be tolerated. Kevlar® maintains its properties at cryogenic temperatures and does not become brittle.

Free length comparison



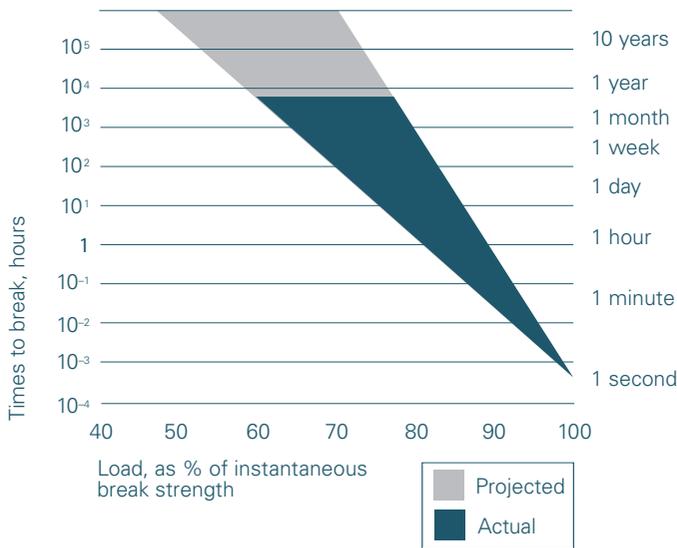
'free length' is the length at which a rope breaks under its own weight. It can be found by dividing a rope's break strength by its weight.

		Kevlar® 29 Standard tenacity, standard modulus	Kevlar® 49 High modulus	Kevlar® 129 High tenacity
Decitex		1670	1580	1670
Density	(g/cm ³)	1.44	1.44	1.44
Tenacity	(cN/tex) (Gpa)	207 3000	201 2900	238 3427
Modulus	(cN/tex) (Gpa)	5160 74	7517 105	6810 95
Elongation at break	(%)	3.5	2.5	3.4
Decomposition temperature in air	(°C)	427-482	427-482	427-482

This table is provided for guidance only. A range of decitexes and finishes are available for each Kevlar® fibre type. Decomposition temperatures will vary according to the rate of heating. Properties will vary according to specific fibre types decitex and detailed specifications are available from DuPont.

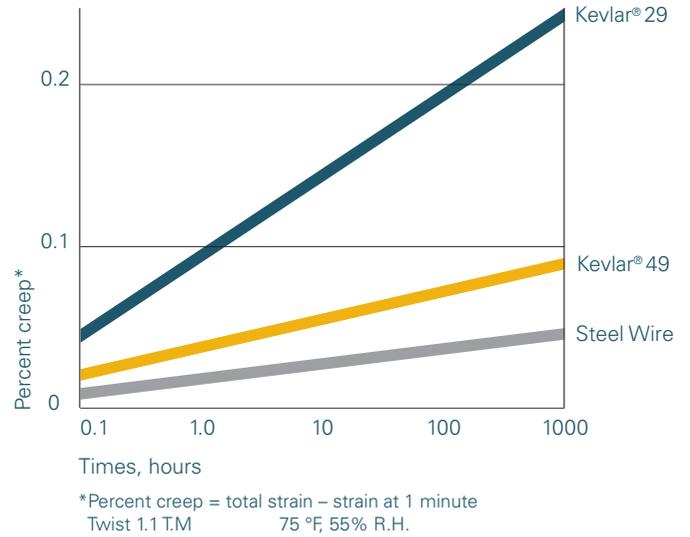


Stress rupture of yarns at room temperature measured under constant load



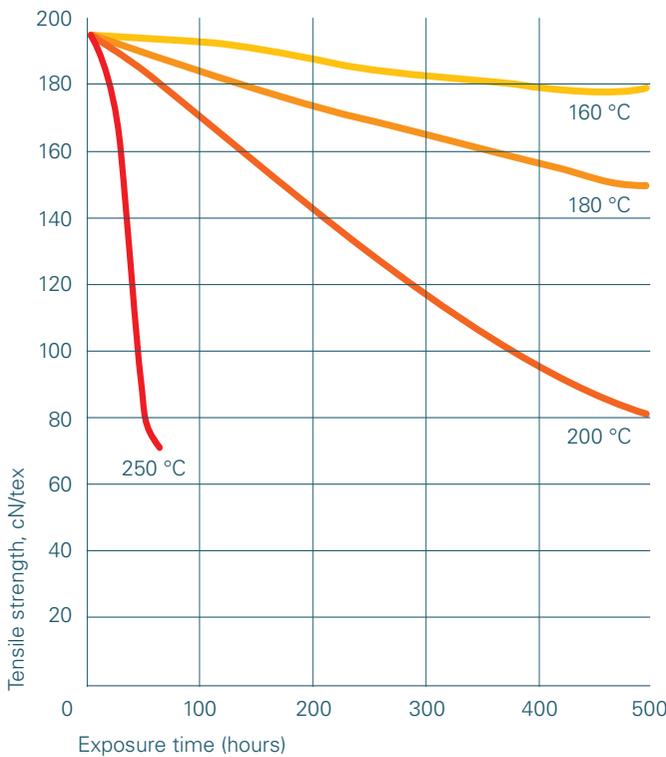
Value for the range of Kevlar® fibres lie within the shaded area. Source from technical report KV-76-50, P.G. Riewald.

Creep performance of Kevlar at 50% of break strength



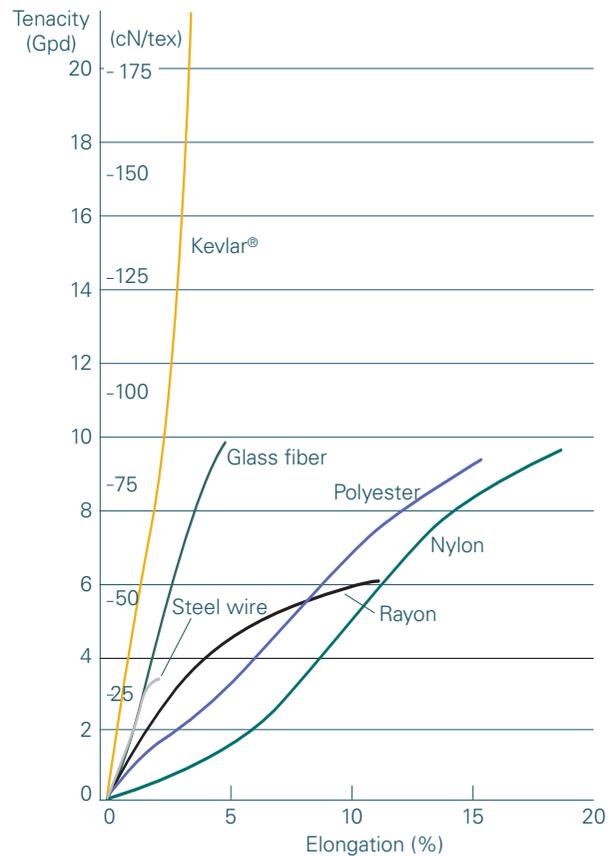
Creep rate of Kevlar® 119 and Kevlar® 129 is similar to that of Kevlar® 29 and is about .05% per decade of time. The creep rate of Kevlar® 49 is about .02% per decade of time. Source from technical report KV-76-50, P.G. Riewald.

Kevlar® 29 yarn effect of temperature on tensile strength



Dry, twist-added yarn test 25 cm gauge length 10% / min elongation tested at room temperature. Source from 'Kevlar® Aramid Fiber for Rope and Cable Applications' report by P.G.Riewald and Venkatachalam.

Comparison of stress-strain behaviour



Source from technical report KV-98-2 by Gallini.



DuPont is a leading global supplier to the oil and gas industry

More than any other, the oil and gas industry operates in a world of climatic extremes. Downtime is costly and the reliable functioning of equipment is a key consideration.

DuPont™ Viton® and Kalrez® products provide excellent sealing to improve the performance and operating life of plant and equipment in harsh conditions, as do Krytox® lubricants. DuPont™ Kapton® and Teflon® materials provide electric insulation and ensure the mechanical and dielectric strength over a wide range of temperatures.

The full DuPont product list includes StreaMax™ pipe coatings that prevent downhole pipe corrosion and improve flow assurance. Additives such as DuPont™ Tyzor®, Anthium Dioxide® and Zonyl® enhance oil well productivity. DuPont clean air technologies help refineries meet environmental requirements. The company is also a world leader in personal protection apparel. The proven performance of DuPont™ Nomex®, Kevlar® and Tyvek® products in protecting against thermal, electrical, chemical and mechanical hazards is widely valued.

DuPont Safety Resources offers a full consulting service to the industry.

For more information, visit www.poweredbyscience.dupont.com





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