I-COATS IMPROVES PROCESSING VECTRAN® ON A ROBLON TWISTER

Introduction:
Herewith the test results for coating Vectran® fibers during twisting on the Roblon Tornado 300 are described. The Tornado had been fitted with a newly designed pulley brake system for controlling the balloon control, ensuring equal yarn length.

Two different yarn grades were tested applying two coatings. The purpose of the test was to maximize the process ability and improve secondary properties of the treated fiber in rope applications.

Partners involved:

Kuraray
As an industry-leading textile fiber manufacturer, Kuraray has been providing innovative technical and industrial textile solutions for over 80 years.

Vectran® is a high-performance multifilament yarn spun from Liquid Crystal Polyester (LCP). Vectran® fiber exhibits exceptional strength and rigidity. Pound for pound Vectran® fiber is five times stronger than steel and ten times stronger than aluminum. Vectran® fibers offer very low creep, resistance to abrasion and fatigue, and thermal/chemical stability across a wide range of environments. Vectran® is used in a variety of industrial, military, and aerospace applications as tension members, cable reinforcement, and protective fabrics.

Tensile strength	23-26 g/denier 412-465 ksi
Tensile modulus	525-585 g/denier 9.4-10.5 Msi
Elongation at Break	3.3% -3.7%
Density	1.4 g/cm^3 0.05 lbs/in^3

Table 1: Vectran® fiber properties.

For a detailed description of Vectran®:
http://www.vectranfiber.com/general_properties.asp

Roblon
ROBLON Engineering was established in 1978 as a separate division of the ROBLON group. Since 1978, Roblon Engineering has developed an extensive product range consisting of machinery and accessories for the production of twine, rope, and cables. Today they are world wide recognized for reliability, high quality, and an excellent service level. This, combined with the versatility of Roblon machines, has placed Roblon as the leading manufacturers of machines for the twine and rope industry as well as the cable industry.

The ROBLON Tornado 300 is a two-for-one twister particularly suitable for production of rope yarns, industrial fibers, tying twine and baler twine, as well as for plying pre-twisted yarns.
For a detailed description of the Tornado 300 :
http://www.roblon.dk/en/roblon_engineering/ropemaking_equipment/twisting_machines/tornado_300/

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I-Coats N.V.
I-Coats N.V, Innovative Coating Solutions, located in Belgium, was founded in 2006 as a spin-off from **GOVI N.V's** successful rope and netting business-unit. The main driver for this initiative has been the continuous willingness to offer to the actual market an ever improving and more focused tailor-made service.

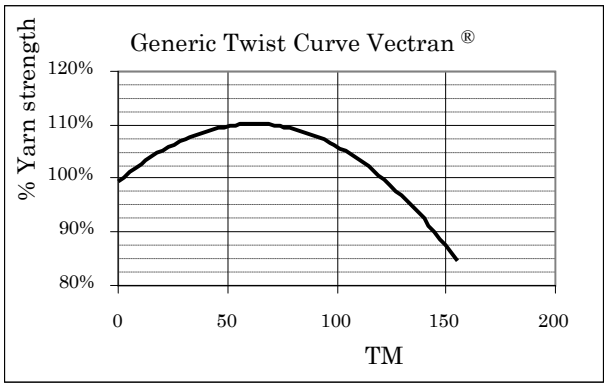
The rope, netting and cable industry has indeed shown over the last years a keen interest in specialized, tailor-made coatings to meet its most important participants' individual needs.
I-Coats N.V. commits to focus exclusively on those needs and will provide the worldwide market with the solutions it has been looking for.

Generally speaking coatings can be used to give protection to a fiber or rope, where wear or abrasion occurs in the application. Our coatings can be used to improve the quality of the rope; first of all to improve the fiber interaction and load sharing. This gives better product consistency with more repeatable break values, thus allowing lower design factors or reduced sizes in the end use. A third reason for using coatings is to optimize the splice behavior, through friction modification, ensuring that the friction between fibers in the splice is high enough where necessary. Last, but not least benefits of having a consistent high-quality coating can be further enhanced through special additives, such as dyes, flame retardants, anti-foulants, U.V. protection. For a detailed description of the product range of I-Coats:
www.i-coats.be

Vectran® properties
Kuraray has two different kinds of spin finish that are mainly used on Vectran® for rope applications:

T-97 A silicone oil finish.
T-117 An olefin finish.

The twisting behavior of Vectran® can be described using a Twist Multiplier (TM) in combination with a normalized twist curve, see graph:



$$TM = K \times twist \times \sqrt{(yarn\ count)}$$

With K=1 if the twist is expressed in turns per inch (tpi) and the yarn count in denier. K= 0.0268 if the twist is expressed in turns per meter (tpm) and the yarn count in dtex. From the curve it is estimated that the optimum TM is between 50 and 100.

Assuming a perfect, parallel assembly of the base yarns, the strength of the assembled yarn can be calculated from the properties of the base yarn. Using a bi-variate, normal distribution to describe the load-elongation behavior and ignoring load-sharing between the base yarns, the assembled strengths are estimated, see also table 2.

Nr of ends	Opt twist		Ave Break Strength	
	tpm		N	g/den
1	62 - 88		423	27,9
5	28 - 39		2008	26,5
10	19 - 27		3974	26,3
15	16 - 22		5886	25,9

Table 2: Ideal assembly HT 1500.

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The properties of Vectran® which are directly influenced by coating prior to processing are the load sharing between the yarns and the abrasion resistance. These will be evaluated here.

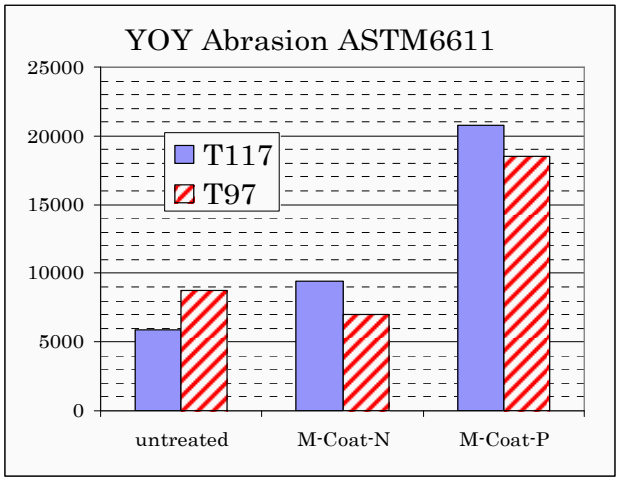
M-COAT-P and M-COAT-N

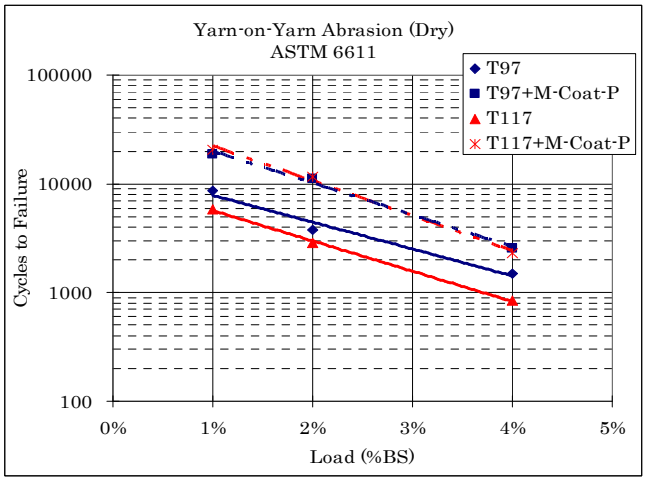
These coatings have been developed for use on polyester and nylon in a marine environment and will improve assembled yarn strength and abrasion resistance (following ASTM6611).

M-COAT-N is silicone based, whereas M-COAT-P is Polyethylene based. Typically there should be 3-5 weight% dry coating on the yarns.

With M-COAT-N an improvement on the T117 finish is achieved, however it does not give an improvement on the T97, when applied to the base yarn. This can be expected with a silicone coating on a silicone finish.

M-COAT-P shows the best performance in abrasion resistance. See also graphs. When M-COAT-P is analyzed over a wider load range it can be seen that its abrasion performance is independent of the yarn type selected here (T97 or T117).





Twisting tests

Two types of Vectran® yarns were optimized:
HT1500/300 T97
HT1500/300 T-117

Two types of coating were applied:
M-COAT-P: (for Polyester)
M-COAT-N: (for Nylon)

Application of the coatings was performed with a kiss-roll connected to the Roblon machine. For the successful processing of Vectran® with the Marine Finish Overlay minor modifications were made on the equipment.

Results

A first series of runs were done to select processing parameters. The second test series are reported here. Breaking strengths were tested on a Zwick tensile tester using standard bollard clamps. Average results are based on at least three test. See also table 3.

When strength results for the different assemblies are

yarn	ends	Coating	Ave BS (N)
T97	5	None	2056
T117	5	None	2133
T117	10	None	4133
T117	15	None	5975
T97	5	M-COAT-P	2175
T117	5	M-COAT-P	2073
T117	10	M-COAT-P	4038
T117	15	M-COAT-P	6326
T97	5	M-COAT-N	2159
T117	5	M-COAT-N	2075
T117	10	M-COAT-N	4093
T117	15	M-COAT-N	6056

Table 3: Results at Roblon.

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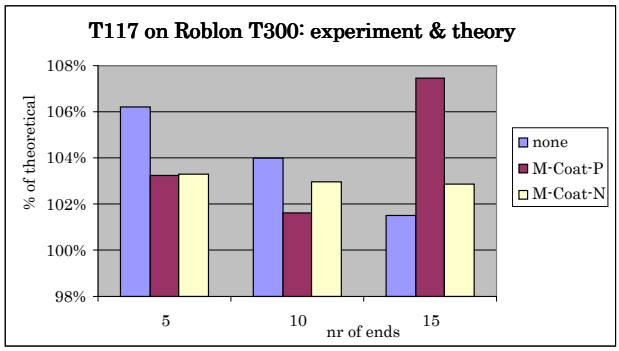
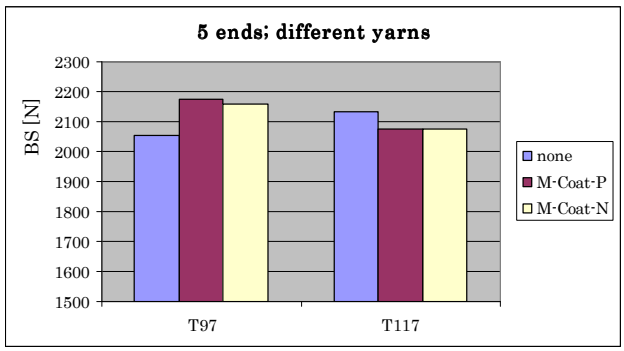
compared between the T97 and T117, then the results are comparable. Also when M-COAT-P and M-COAT-N are compared their effect on strength is comparable.

The experimental results are slightly above the ideal values, this is probably caused by load-sharing.





Conclusions

Yarn on Yarn Abrasion with M-COAT-P scores high. M-COAT-P gives an improvement on the T117 (3.5 times) and on the T97 (1.6 times). This coating has overall the best dry YOY abrasion, the level of abrasion resistance achieved is independent of the yarn finishes compared here.

Assembling T97 and T117 on a modified Roblon Tornado 300 gives a strength on the same level or above that of an ideally assembled yarn. Applying M-COAT-N or M-COAT-P during twisting with a kiss-roll can be done at regular processing conditions, with a minimal effect on equipment or maintenance.

From the tests it can be concluded that Vectran® fibers can be processed on a Roblon Tornado 300 with minimal modifications. The twist behavior can be described by a normalized twist curve. For optimal abrasion resistance and stability in subsequent processing it is shown that M-Coat-P should be applied in the process.

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