THE ADVANTAGES OF FORTIFIED SKIN

Application on the insulation and sheath of the Cables

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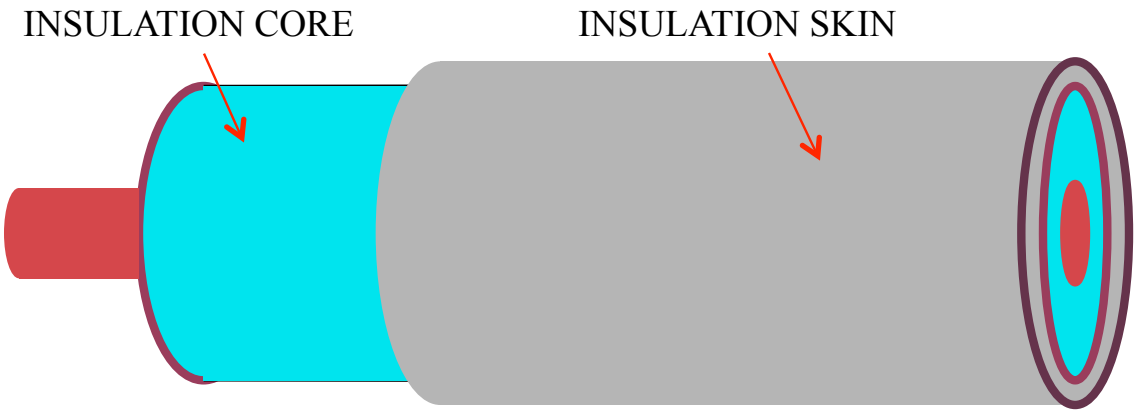
INTRODUCTION

* **Two different extruders are used in skin extrusion; one to produce the insulation core and the other the skin surface layer**



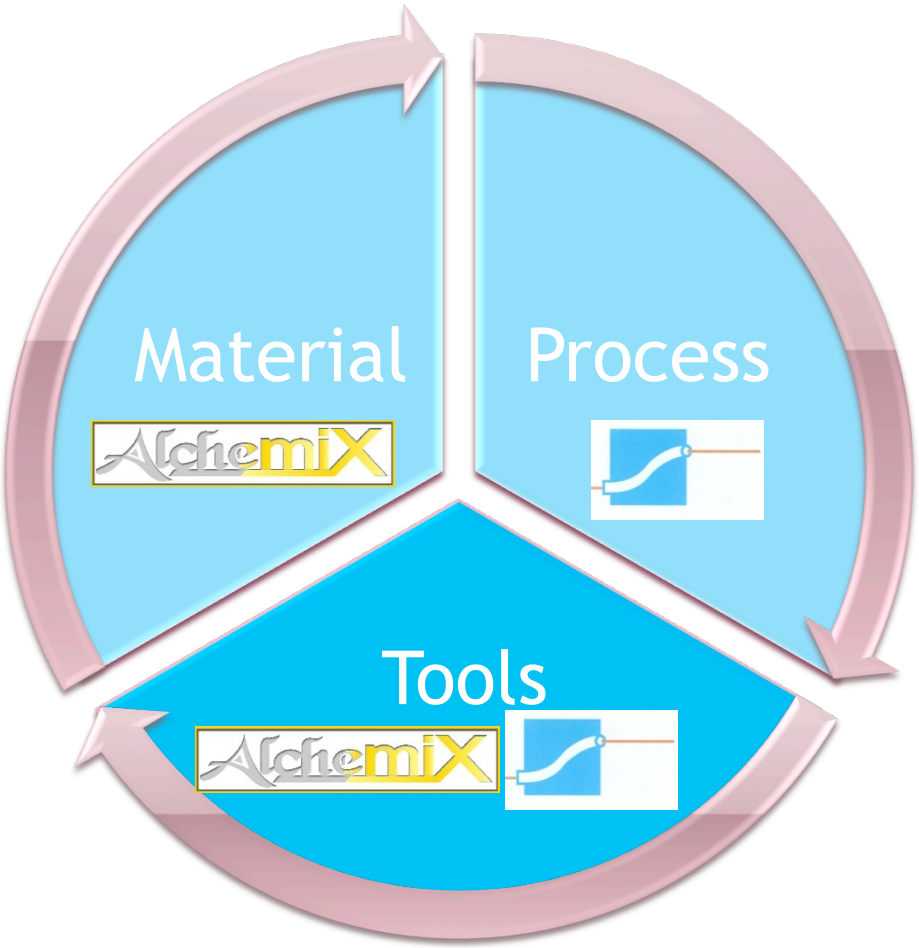
Skin fortified with

a) Colorants
b) Anti vermin
c) UV protection
d) Anti static
e) Anti fungal
f) Anti bacterial

* Besides colorants, other additives can be added to this skin layer to enhance the overall properties of the cable

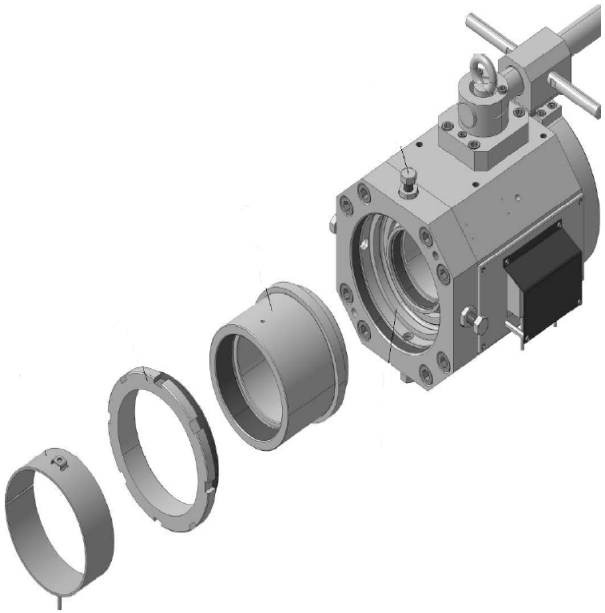
* The **overall thickness** of the cable remains the same

TECHNOLOGY SECTORS



EXTRUSION TOOLS

Essential tools and machinery for Skin application



Cross head for double layer extrusion

Co-Extruders

Vertical

Horizontal

CROSS-HEAD TOOLS AND ACCESSORIES

For precise application of Skin , we need precise tooling :

Die and Nipple

Cartridges (main distributer) and Collet (front distributer) for PE/PVC/XLPE/HFFR/PA ….

All cost savings are highly dependent to precise tooling

REASONS

Reduction in the use of expensive colour or additive masterbatches:
Because expensive materials are added only to the skin layer and not the whole insulation

Reduction in down time for cleaning:
cleaning the main extruder which runs only a homogenous product is easier vs cleaning the smaller skin extruder which runs a variety of masterbatches.

Reducing waste generated in purging:
A large amount of extrudate in the main extruder is purged vs the smaller amount of extrudate generated from the smaller skin extruder. This is especially true for colour changes.

Keeping the insulation clean:
it is ironical that stringent steps are taken to maintain cleanliness before and during extrusion, then "contaminants" are added to the insulation

Customization:
The core and the skin, for compatibility reasons, should be made of the same class of polymeric material, however different grades, one type for the core and another for the skin, to improve the overall performance of the cable.

SCOPE OF STUDY

The scope is categorized into 2 topics :

A

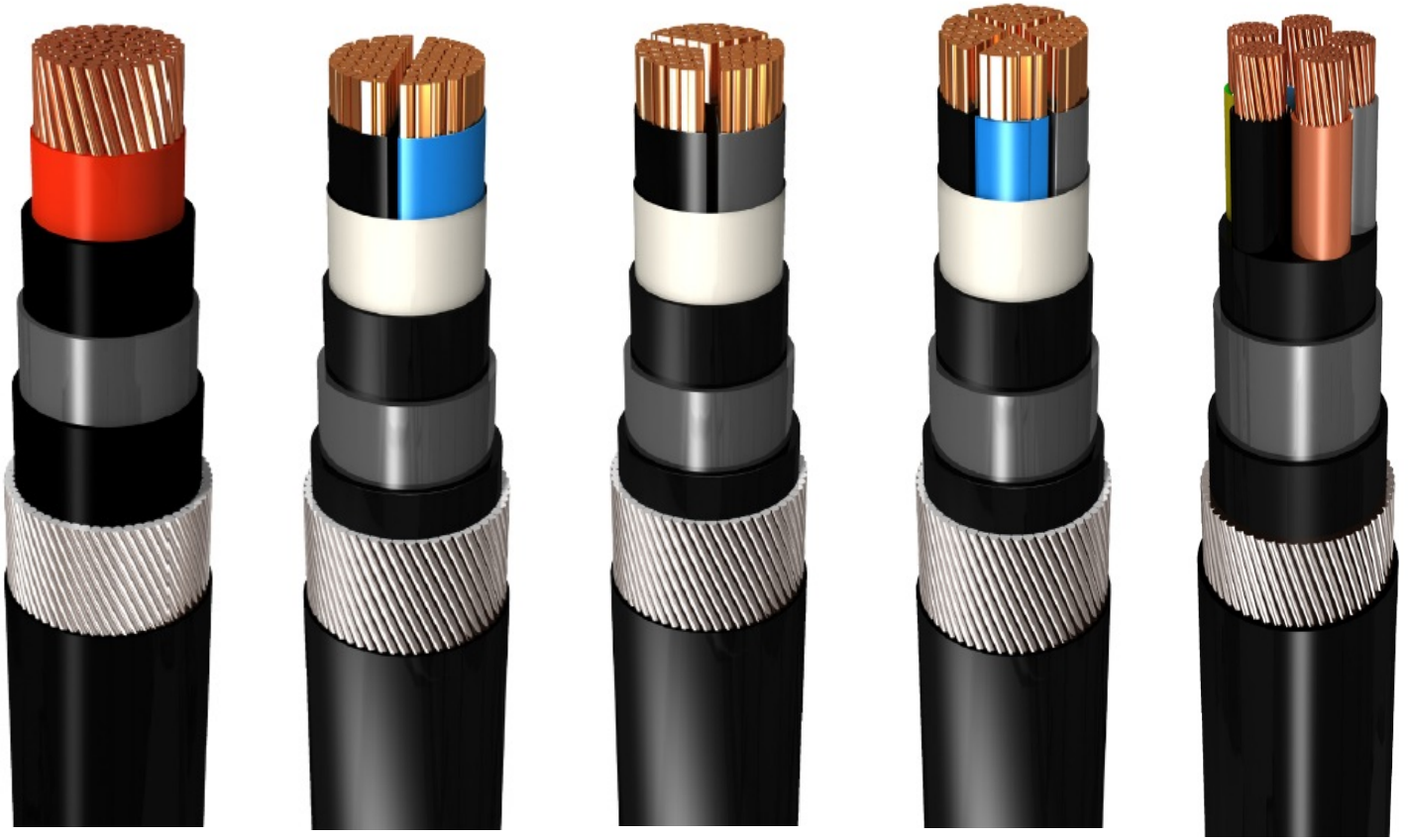
- **Cost savings using skin technology: 2 examples**

B

- **The advantage of skinning in ABC cables Insulation**

COST SAVINGS

COLORED INSULATION SKIN OF LV CABLES



LV CABLE'S INSULATION

6 month record Cable Factory Production (actual case study from Feb 2014 to July 2014)

Conductor Xsection Area	Insulation Total Thickness mm	(According to company Cable Records)		Master-batch saving on Skin
		Production over half a year (meter)	Number of Productions	
mm2	(IEC 60502-1)	meter	No.s	kg/kM
16	0.7	447,767	135	0.19
25	0.9	231,593	118	0.22
35	0.9	160,583	100	0.24
50	1.0	146,151	145	0.32
70	1.1	100,940	110	0.43
95	1.1	71,391	84	0.49
120	1.2	99,937	81	0.62
150	1.4	61,742	50	0.83
185	1.6	55,115	38	1.08
240	1.7	62,162	49	1.32
300	1.8	89,968	46	1.56
400	2.0	3,797	4	1.97
500	2.2	400	1	2.48

The major Savings are concentrated on :

1. **Reduction** of used color masterbatch
2. **Reduction** of waste material due to color exchange
3. **Reduction** of electricity consumption on color change
4. **Reduction** of over consumption by using more precise extrusion tooling

COST SAVING ON COLORED INSULATION

Details of Saved Material and Energy

Conductor section Area	Skin (0.2mm) Weight	Insulation Total Weight (Core+Skin)	Insulation Overall Diameter	Sub total of Master batch	x2 For 3 Cores different colors waist	x2 For 3 Cores different colors waist
mm2	kg/kM	kg/kM	mm	KG	kG	KWH
16	3.6	16.1	6.5	84	675	3,375
25	4.6	19.3	8.22	51	590	2,950
35	4.9	20.8	8.8	38	500	2,500
50	5.7	26.9	10.2	46	725	3,625
70	6.8	35.4	12.1	43	550	2,750
95	7.8	40.5	13.7	35	420	2,100
120	8.8	49.8	15.4	61	405	2,025
150	9.9	65.0	17.3	51	250	1,250
185	11.0	82.7	19.3	59	190	950
240	12.6	100.3	21.9	82	245	1,225
300	13.9	117.8	24.2	140	230	1,150
400	15.7	147.3	27.2	7	20	100
500	17.7	183.2	30.7	1	5	25

1. • Saved master batch 1,400 Kg/ year saving 6,300 USD/year
2. • Saved XLPE due to color change in smaller extruder about 10 tone/ year , making 24,000 USD/year
3. • Saved electrical energy in quicker way and in smaller extruder 22,000 KWH/ year , making 4,300 USD/year
4. • Not using extra material by thicker insulation in using more precise tooling (hidden and not included in this calculation)

INTERNATIONAL STANDARDS

IEC 60502-1 (2009) or **IEC 60502-2** (2014)
(Low and Medium Voltage Cables)
Requirements for **Anti-Rodent** & **Anti-Termite** additives in OverSheath

Section 13.2 of IEC 60502-1 (same as section 14.2 in IEC 60502-2) :
The chemical additives may be necessary in the oversheath for special purposes , for example termite protection, but **they should not include materials harmful to mankind and/or environment** .

Like Aldrin , Dieldrin , Lindane

SUITABLE ADDITIVES COMPLY STANDARD

Anti-Rodent , Anti-Termite Masterbatch :

* Non-toxic ingredients (Environmentally friendly, heavy metal free ….)

* Product based on EVA as carrier (to be used both for PVC , PE , HFFR , …) compounds

AEGIS AR B-3251 Anti-Rodent

AEGIS AT P-3151 Anti-Termite

* It causes an extremely unpleasant sensation when rodents tried to bite the finished products. Such intense and unpleasant sensation deters rodents from further attempts to attacks.

APPLICATION OF ANTI-RODENT IN SKIN

A list of Different cable size (from 10 mm to 100 mm)

Row	Cable Name	Cable Size	Jacket Thickness (mm)	Overall Diameter (mm)	Jacket Weight (gr/m)	Skin Thickness (mm)	Skin Weight (gr/m)	Ratio of Skin to Jacket (%)
1	N2XY	1x4 rm	1.4	6.8	34.7	0.4	11.7	34%
2	N2XY-O	2x1.5 rm	1.8	10.8	74.3	0.4	19.1	26%
3	N2XY-O	2x6 rm	1.8	14.2	102.4	0.4	25.3	25%
4	N2XY-O	2x16 rm	1.8	18.6	138.7	0.4	33.4	24%
5	N2XY-O	2x70 sm	1.8	23.7	180.8	0.4	42.7	24%
6	N2XY-O	2x120 sm	2.1	30.7	275.5	0.4	55.6	20%
7	N2XY-O	2x185 sm	2.3	36.7	362.9	0.4	66.6	18%
8	N2XY-O	2x240 sm	2.5	41.4	446.0	0.5	93.8	21%
9	N2XY-O	2x400 sm	2.9	52.3	657.1	0.5	118.7	18%
10	N2XSEYKYRY-O	3x25/16 8.7/15KV	2.8	61.1	748.7	0.5	138.9	19%
11	N2XSEYKYRY-O	3x50/16 8.7/15KV	3.0	67.2	883.4	0.5	152.9	17%
12	N2XSEYKYRY-O	3x70/16 8.7/15KV	3.2	73.4	1030.3	0.5	167.1	16%
13	N2XSEYKYRY-O	3x120/16 8.7/15KV	3.5	81.2	1247.3	0.6	221.7	18%
14	N2XSEYKYRY-O	3x185/25 8.7/15KV	3.8	90.6	1512.8	0.7	288.5	19%
15	N2XSEYKYRY-O	3x240/25 12/20KV	4.1	102.9	1857.9	0.8	374.5	20%

* We have considered jacket thickness from 1.4 to 4.1 mm

* Skin (having Anti-Rodent M.B) having thickness of 0.4 to 0.8 mm .

* Weight of Skin , is about 20% of whole sheath

SAVINGS OF ANTI-RODENT ORDINARY PROTECTION

Fortified Anti-Rodent SKIN Calculation and Savings using **3% M.B in Skin**

Row	Cable Name	Cable Size	Anti Rodent Weight in Whole sheath (gr/m)	Anti Rodent Weight in Skin (gr/m)	Saving of Anti Rodent Master batch
1	N2XY	1x4 rm	1.0	0.4	195%
2	N2XY-O	2x1.5 rm	2.2	0.6	290%
3	N2XY-O	2x6 rm	3.1	0.8	305%
4	N2XY-O	2x16 rm	4.2	1.0	316%
5	N2XY-O	2x70 sm	5.4	1.3	323%
6	N2XY-O	2x120 sm	8.3	1.7	396%
7	N2XY-O	2x185 sm	10.9	2.0	445%
8	N2XY-O	2x240 sm	13.4	2.8	376%
9	N2XY-O	2x400 sm	19.7	3.6	453%
10	N2XSEYKYRY-O	3x25/16 8.7/15KV	22.5	4.2	439%
11	N2XSEYKYRY-O	3x50/16 8.7/15KV	26.5	4.6	478%
12	N2XSEYKYRY-O	3x70/16 8.7/15KV	30.9	5.0	517%
13	N2XSEYKYRY-O	3x120/16 8.7/15KV	37.4	6.7	463%
14	N2XSEYKYRY-O	3x185/25 8.7/15KV	45.4	8.7	424%
15	N2XSEYKYRY-O	3x240/25 12/20KV	55.7	11.2	396%

- Normally it's recommended to use 3 % Anti-Rodent M.B in the outer Sheath

- By application of Anti-Rodent M.B. limited to Skin , we can save in average 400% meaning **1/5 of Whole Jacket having M.B**.

SAVING OF ANTI-RODENT EXTRA-ORDINARY PROTECTION

Fortified Anti-Rodent SKIN Calculation and Savings **using 7% M.B**

Row	Cable Name	Cable Size	Anti Rodent Weight in Whole sheath (gr/m)	Anti Rodent Weight in Skin (gr/m)	Saving of Anti Rodent Master batch
1	N2XY	1x4 rm	1.0	0.8	27%
2	N2XY-O	2x1.5 rm	2.2	1.3	67%
3	N2XY-O	2x6 rm	3.1	1.8	73%
4	N2XY-O	2x16 rm	4.2	2.3	78%
5	N2XY-O	2x70 sm	5.4	3.0	81%
6	N2XY-O	2x120 sm	8.3	3.9	112%
7	N2XY-O	2x185 sm	10.9	4.7	134%
8	N2XY-O	2x240 sm	13.4	6.6	104%
9	N2XY-O	2x400 sm	19.7	8.3	137%
10	N2XSEYKYRY-O	3x25/16 8.7/15KV	22.5	9.7	131%
11	N2XSEYKYRY-O	3x50/16 8.7/15KV	26.5	10.7	148%
12	N2XSEYKYRY-O	3x70/16 8.7/15KV	30.9	11.7	164%
13	N2XSEYKYRY-O	3x120/16 8.7/15KV	37.4	15.5	141%
14	N2XSEYKYRY-O	3x185/25 8.7/15KV	45.4	20.2	125%
15	N2XSEYKYRY-O	3x240/25 12/20KV	55.7	26.2	113%

- For some extra-ordinary application and usage of Anti-Rodent outer sheath We have considered 7% M.B

- In this case we have made stronger outer sheath of cables against Rodent attack **at least 2 times** more than normal.

- And we have saved in average 110 % of Anti-Rodent meaning , we used **1/2 M.B comparing to whole sheath** .

VERIFICATION ACCORDING TO IEC 60502

All sheath are tested according to IEC 60502-1 & 2 grade **ST2**

Test Item	Sheath Type	Standard Requirement	Test Result
Tensile Strength before aging	Anti Termite	MIN 12.5N/mm2	16.8 N/mm^2
	Anti Rodent		17.5 N/mm^2
	Normal		13.3 N/mm^2
Tensile Strength aged	Anti Termite	MIN 12.5N/mm2	16.9 N/mm^2
	Anti Rodent		17.7 N/mm^2
	Normal		13.7 N/mm^2
Variation	Anti Termite	MAX 25%	0.60%
	Anti Rodent		1.10%
	Normal		3.00%
Elongation at Break before aging	Anti Termite	MIN 150 %	275%
	Anti Rodent		221%
	Normal		255%
Elongation at break of aged	Anti Termite	MIN 150 %	251%
	Anti Rodent		266%
	Normal		230%
Variation	Anti Termite	MAX 25%	-9%
	Anti Rodent		20%
	Normal		-10%

Test Item	Sheath Type	Standard Requirement	Test Result
Cold impact	Anti Termite	No Crack	OK
	Anti Rodent		OK
	Normal		OK
Cold elongation	Anti Termite	MIN 20 %	110%
	Anti Rodent		115%
	Normal		115%
Hot pressure	Anti Termite	MAX 50%	11%
	Anti Rodent		10%
	Normal		17%
Heat Shock	Anti Termite	No Crack	OK
	Anti Rodent		OK
	Normal		OK
Loss of mass	Anti Termite	Max 1.5 mg/ cm2	0.89 mg/ cm^2
	Anti Rodent		0.7 mg/ cm2
	Normal		0.9 mg/ cm2

* Conclusion : No mechanical/thermal properties is compromised with high dosage of additives

ANTI-RODENT/TERMITE – TEST SAMPLES

We have tested 3 identical cables NYY-O 3x2.5 mm2 rm

Sample A : having ordinary jacket

Sample B : having 7% anti-rodent in skin

Sample C : having 7% anti-termite in skin

* We have selected **non-armoured** and **small cable** for test in order to show ultimate reliability of used method (in bigger cables and other cable design having metallic layers the damage of termite/rodent attack will be considerably less !!!

* Test method is adapted by Chinese test laboratories .

For evaluation of test results , comparisons of number of bites and depth of damage on cable's non-metallic parts is considered .

TEST METHOD

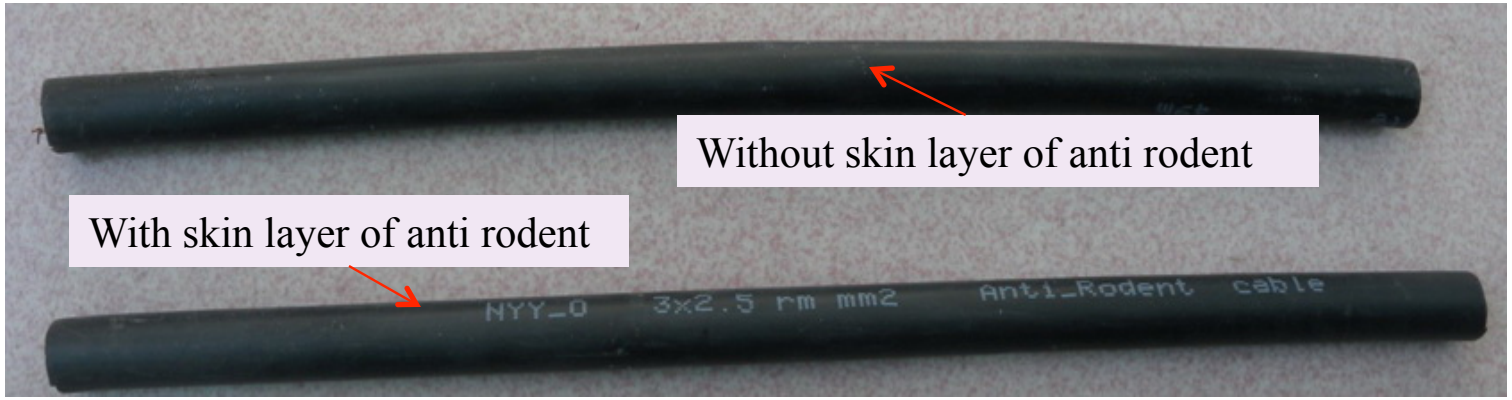
The test was based on the **JB/T 10696.10.2011**
Test method for determining mechanical , physical and chemical properties of cables and wires

Part 10 : Rat gnawing test.

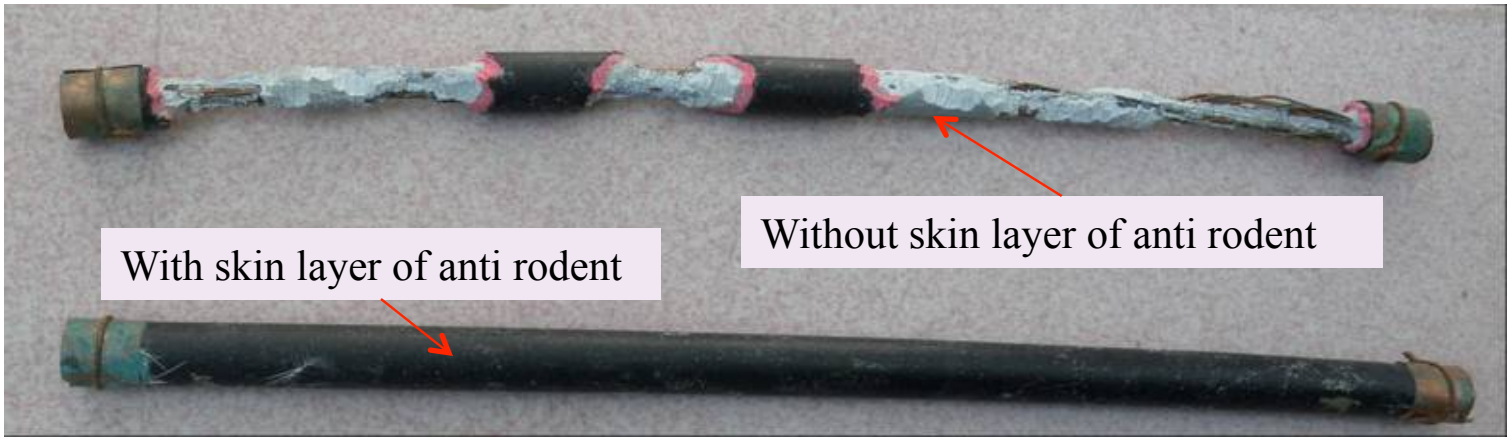
Protective class	Protective rate	Description of Wires and Cables gnawing status
Significant	>= 0.9	No teeth trace gnawed by rats on the surface or slight teeth trace
Better (Medium)	>= 0.7	Heavy teeth trace (the gnawed depth is less than half of the sheath thickness , the coat layer is not perforated)
General	>= 0.5	Heavy teeth trace (the gnawed depth is more than half of the sheath thickness , the outer jacket is not perforated)
Failure	---	Perforation in the surface of outer jacket of cables
	<0.5	---
	Else	The rats were died because of poisonous repellent in cable outer sheath.

RODENT ATTACK

Before test



After test



TEST RESULTS

Test Lab :
Guangdong
Entomological Institute
(Guangzhou , China)

In sample Having fortified Skin of Anti-Rodent :

Small teeth trace gnawed by rat on the surface .

The protective rate >=0.9 .

The resistance quality is graded as Significant.

File number: GDEI-2014128

Test Report

Name of products: Anti-Rodent Cable

Type of products: Cable

Consignor: Plexchem Technologies

Test category: Entrust inspection

Test Method: JB/T10969.10.2011

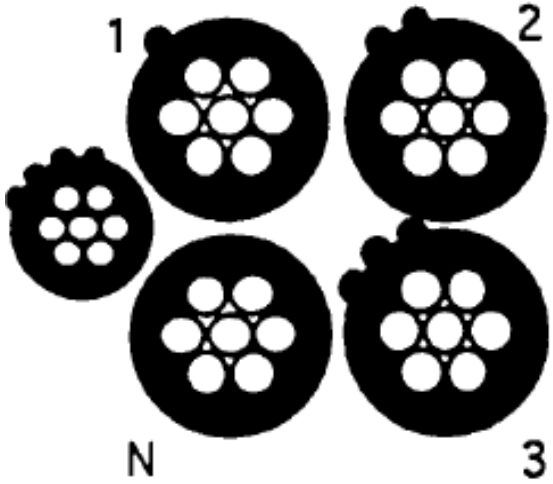
Guangdong Entomological Institute

Test report by
Guangdong Entomological Institute

Name of products	Anti-rodent Cable	File number	GDEI-2014128		
Type of products	Cable	Raw materials of products	--		
Test category	Entrust inspection	State of products	Black, Φ=50mm		
Consignor	Plexchem Technologies	Address	NO 8 PENJURU PLACE, BLK 8 # 01-39 PENJURU TECH HUB .SINGPORE 608780		
Production unit of raw materials	ST2- ART	Date of report	19th Jan 2015		
Sampling method	Submitted sample	Zip code	608780	Tel	(65)62640288
Test methods	The test was based on the JB/T 10696.10--2011, Test method for determing mechanical, physical and chemical properties of electric cables and wires—Part 10: Rat gnawing test.				
Date of test	Dec.19th 2014 to Jan.21st 2015				
Test results	Small teeth trace gnawed by rat on the surface of the samples. The protective rate ≥ 0.9. The test samples have significant effect on anti-rodent. For the diameter of the test samples (Φ=50mm) are bigger than the requirements of the standard, the test results are just as a reference.				
Note	1). The entrust inspection is responsibility for the received sample only. 2). To assure the accuracy of the test, the test samples should be less than 30mm in diameter. 3). Examine and visually rate using the following rating system (See Table 1)				
Approve	Zhong Jun-hong Professor Signature:	Audit	Li Qiu-jian Vice-Professor Signature:	Main check	Liu Bing-rong Engineer Signature:

ADVANTAGES OF SKINING FOR ABC CABLES

BLACK SKIN OF ABC CABLES INSULATION



OUTSTANDING POINTS IN ABC OVERHEAD CABLES:

- **Ultra Violet radiation from direct sunshine**

is the major cause in deteriorating of ABC cross-linked cables, with respect to poor dispersion and improper particle size and insufficient amount of carbon black.

- **SOLUTION:**

addition of higher levels of carbon black especially in areas where year round sunshine is prevalent

PROBLEMS ASSOCIATED IN ADDING MORE CARBON BLACK

- Reduction in production speed
- Dull surface
- Higher levels of pre-crosslinking

THE PURPOSE OF THE STUDY

- We studied the results obtained by applying the same amount of the related masterbatch to the whole insulation vs only to the insulation skin layer was compared .

- We will also report our investigation on the effects of the electrical properties obtained when **2.5 % of carbon black** was added to the whole insulation as compared to the electrical properties of the cable when the same level of masterbatch is confined only to the skin layer.

IMPORTANT NOTE !

* The base materials for the core and the skin are made using a PE polymer each having different melt flow Indexes and density

Because they are both **PE** based the cable is fully bonded to each other and the skin and core cannot be physically separated

* The core consist of a PE polymer that would impart excellent mechanical and chemical properties

The skin is made of a fast flowing PE polymer

HD 626 – INSULATION TYPE TIX-5

Superior Mechanical/Thermal characteristics meeting HD626 as the best choice for insulation

	HD 626	Normal XLPE
Tensile Strength (before aging) N/mm2	**14.5**	12.5
Aging Condition (temperature / time)	**150 'C 240 h**	135 'C 168 h
Hot set test , Mechanical load	**0.3 Mpa**	0.2 Mpa

This grade covers all other Standards :

- ASTM D.1248 , Type III , category 4
- NFC 33209 (and so called Facade cables)
- AS 3560 , 3675
- ANSI/ICEA S 66-524 , S 70-547
- HD 603 S1 , HD 626 (TIX 1 ,3 , 5 , 7 , 8)
- NP 3528
- SFS 5701
- SS 424 14 63 and UNE 210302R

SILOXANE XLPE PRODUCTION LINE

Silane XLPE absorption Line

SILOXANE XLPE COMPOUNDS

Alchemix **XLPE-130K** (Natural) as Core

* Mechanical
* Thermal
* Dielectric Strength
* Faster curing

Alchemix **XLPE-135K** (Black) as Skin

* Better processing in extrusion
* Smooth and Shiny surface
* Weather and environmental resistance

A CORE WITH EXCELLENT MECHANICAL PROPERTIES

THE ABC CABLES ARE SUBJECTED TO HIGH STRESS DUE TO:

- EXPOSURE TO TEMPERATURE EXTREMES ESPECIALLY IN DESERT CONDITIONS
- EXPOSURE TO MOVEMENTS DUE TO WINDY CONDITIONS
- DIFFERENCE IN THERMAL EXPANSION OF PLASTIC INSULATION & ALUMINIUM CONDUCTOR

MECHANICAL / THERMAL TESTS

Comparisons of test results by referencing TIX-5

	Black Skin / Natural Core	Whole Black
Tensile Strength (before aging) N/ mm2	**20.1**	17.9
Tensile Strength (after aging) N/mm2	**17.6**	15
Tensile Strength Variation (after aging)	**12%**	16%
Elongation at Break (before aging) %	**592**	440
Elongation at Break(after aging) %	**508**	370
Elongation at Break Variation (after aging)	**14%**	17%

The resulting cable has a superior surface finish with excellent thermal and mechanical properties that can be processed at extremely high productions speeds.

	Black Skin / Natural Core	Whole Black
Hot set test - Elongation Under Load	**85%**	95%
Hot set test - Permanent Elongation	**3.5 %**	7.5 %
Shrinkage test	**1.5%**	2.0%

BLACK SKIN CALCULATION FOR ABC CABLE

Insulated Conductors and Dimensions according to **HD 626 S1:1996/A2:2002 Part1,2 , 6-E**

Section mm2	Conductor Diameter (mm)	XLPE Insulation thickness (mm)	Total XLPE Weight (gr/m)	**Carbon black (gr/m)**	Skin Weight t=0.2 mm (gr/m)	**Required M.B in Skin**
16	4.8	1.2	21.0	**0.17**	4.1	**10%**
25	5.8	1.4	29.4	**0.24**	4.9	**12%**
35	7.0	1.6	40.2	**0.32**	5.8	**14%**
50	8.2	1.6	45.8	**0.37**	6.5	**14%**
70	9.9	1.8	61.5	**0.49**	7.8	**16%**
95	11.5	1.8	69.9	**0.56**	8.7	**16%**
120	13.0	1.8	77.8	**0.62**	9.6	**16%**

- Following assumptions are made :

1- Insulation thickness acc HD 626-1

2- Skin thickness = 0.2 mm

3- Carbon black content of M.B ; 40%

4- Minimum required C.B ; 2 %

- **Conclusion :**

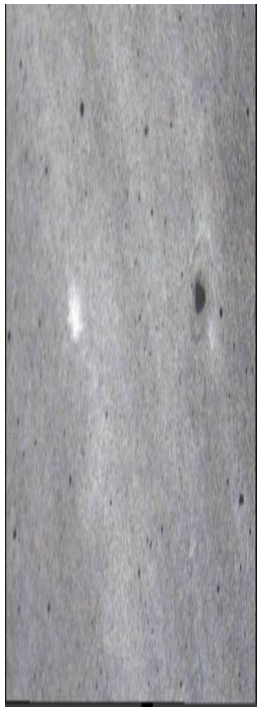
We need on average 16% of Black M.B in skin, to cover standard requirements .

So, we take **20%** in our tests .

HIGHER CONCENTRATION OF BLACK M.B.

Dispersion and Concentration of

5% M.B (2% C.B) vs. **20% M.B** (8% C.B)



* IEC 60811-607 (2012)
Tests for the assessment of carbon black dispersion
* ISO 18553 (2002)
Figures of Grade of dispersion assessment

- Normally Carbone black particle size is requested to be **lower than 20 nm** (for having better dispersion)
- By having higher concentration of carbon black in average ; we will achieve :

1- Higher protection against UV , by more C.B

we applied 4 times more C.B.

2- Lower risk of damage against UV with bigger C.B particle size (and poor dispersion)

ADVANTAGE OF SKIN IN SURFACE

Black Skin vs. Whole Black

1-Although we have used 20% black M.B in skin (comparing to normal whole black insulation that has 5% black M.B) ;
Skin surface is more

SMOOTH and SHINY

2-Following above matter , we experienced

Easier process and
Higher Speed of Extrusion

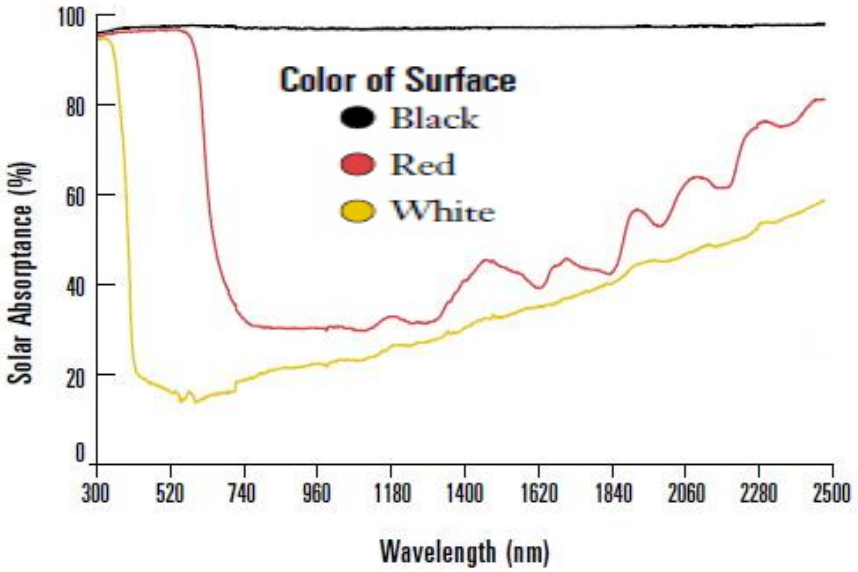
3- Smoother surface practically leads to

HIGHER Abrasion resistance

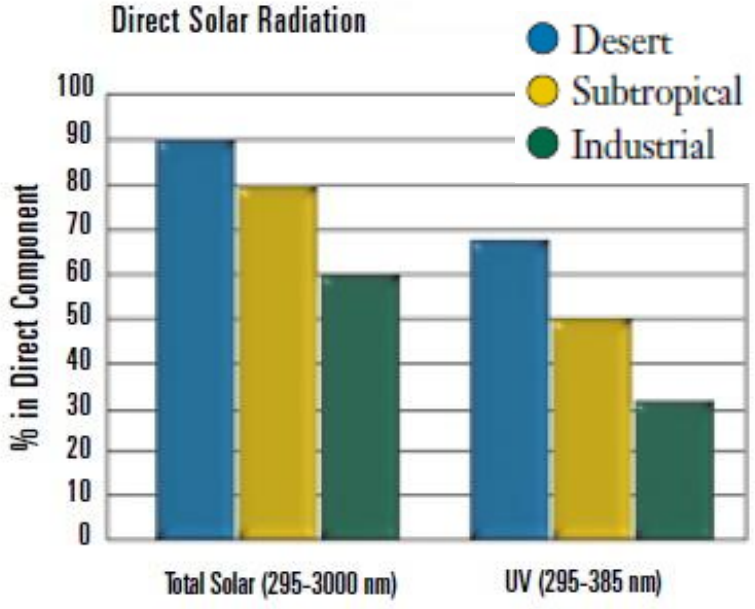
WEATHERING

Weathering is the adverse response of a material or product to climate , often causing unwanted and premature failures.

We attempt to prevent deterioration and premature product failure through chemical or mechanical stabilization and through **weathering tests** to access a material durability.



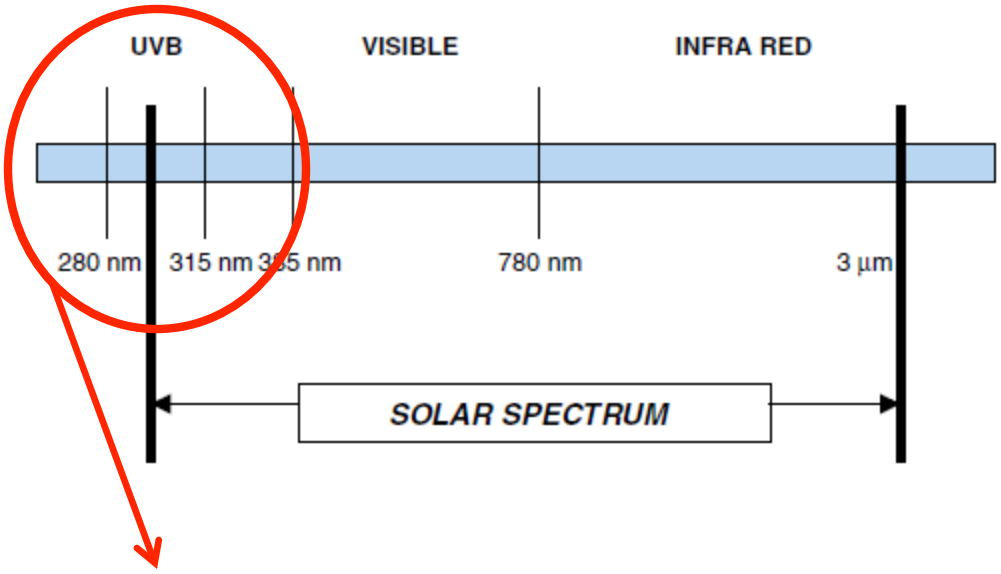
Temperature dependency on color



Solar radiation vs UV in different areas

WEATHERING / EFFECT OF UV

UV radiation :
characterized by short wavelengths is the cause of photo-degradation results in breakdown the polymer chain.



UV range of Solar radiation

Light beam of Xenon lamp ,

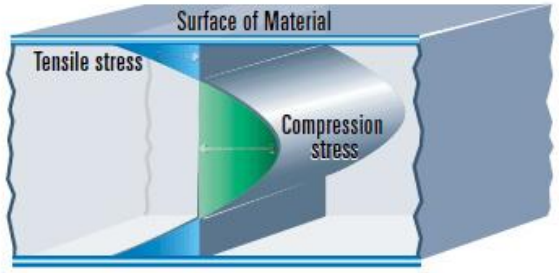
having wavelength between 340 nm to 400 nm is referred in many standards such as ASTM , HD , UL , …. as UV test .

WEATHERING / EFFECT OF MOISTURE

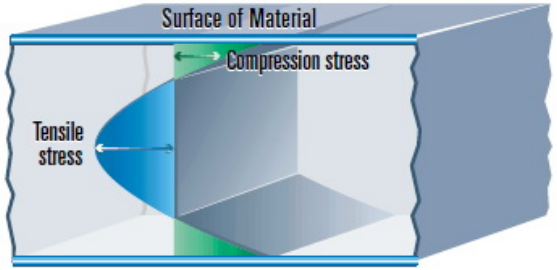
There are two ways in which water affects materials :
Water absorption (from humidity and direct wetness) . When surface absorbs moisture a volume expansion is produced that places stress on the dry subsurface layers.

Water desorption , will occur during drying out period (against sunlight or ….) the surface layers will lead to volume contraction). The hydrated inner layers resist this contraction , leading to **surface stress cracking** .

Desorption



Absorption



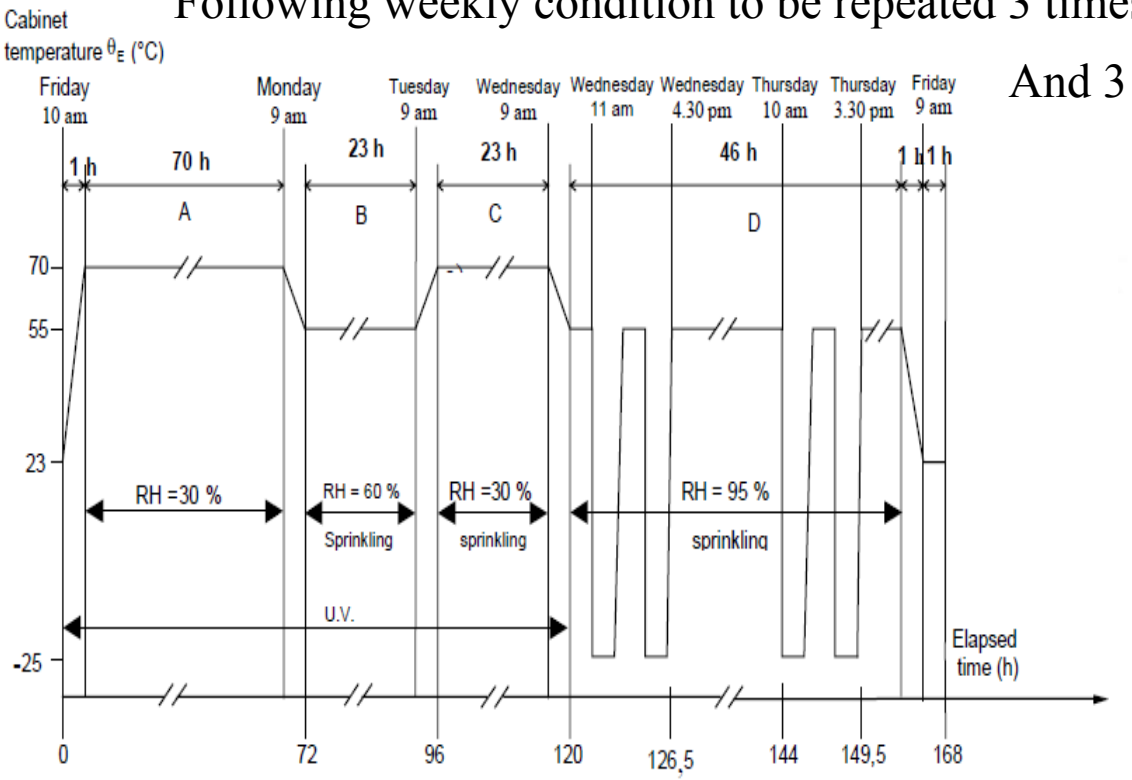
WEATHER RESISTANT TEST OF INSULATION

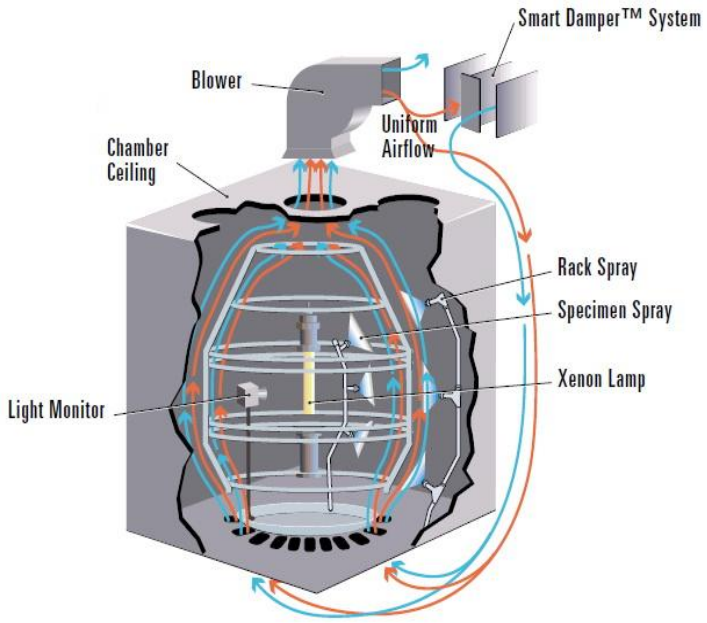
Test Method of **HD 626 S1:1996/A2:2002 Part 2 , Section 2.5.1**

Test Condition : Under light beam of **Xenon-lamp** (at max temp 70 +/- 2'C) , Plus water spray

Following weekly condition to be repeated 3 times (for 1st and 2nd batch of samples)

And 3 times more for 2nd batch of samples





WEATHER RESISTANT TEST EVALUATIONS

HD 626-2 section 2.5.1 test is done is 3 different conditions :

1- Whole Black insulation

2- Black Skin / Core insulation (un-scratched)

3- Black Skin / Core insulation **(scratched)**

Evaluation of results (Tensile strength (R) and Elongation at Break changes (A)) :

1) $\left| \frac{A_2 - A_0}{A_0} \right| \times 100 \leq 30$ $\left| \frac{R_2 - R_0}{R_0} \right| \times 100 \leq 30$

2) $\left| \frac{A_2 - A_1}{A_0} \right| \times 100 \leq 15$ $\left| \frac{R_2 - R_1}{R_0} \right| \times 100 \leq 15$

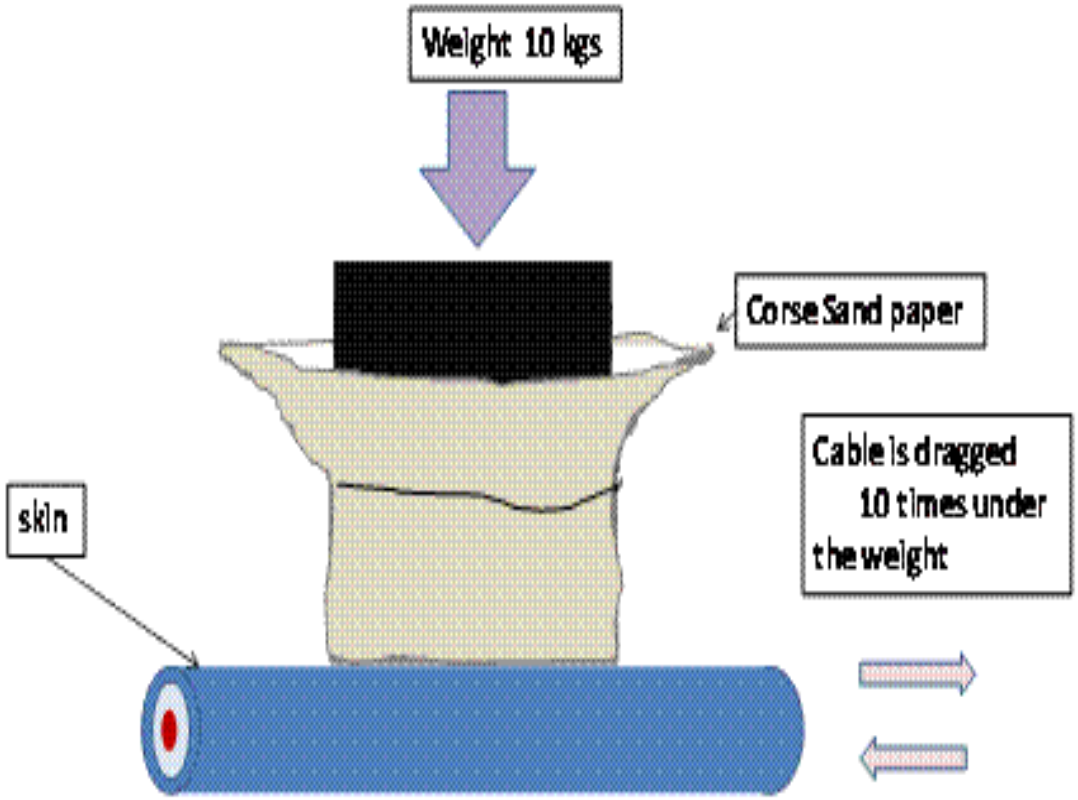
Reference batch : A0 , R0

1st batch : A1 , R1

2nd batch : A2 , R2

Test Duration : 1st batch after 3 weeks (about 500h) and
2nd Batch after another 3 weeks exposure (about 1000h)

TEST FOR ABRASION RESISTANCE



Picture of cables after being abraded

To simulate cable being dragged on the floor

WEATHER RESISTANT TEST RESULTS

	Black Skin / Non Scratched			
	A0	445	**R0**	15.5
	A1	400	**R1**	14
	A2	360	**R2**	12.8
First	**19%**		**17%**	
Second	**9%**		**8%**	

	Black Skin Scratched			
	A0	420	**R0**	14
	A1	390	**R1**	12.1
	A2	310	**R2**	10.5
First	**26%**		**25%**	
Second	**19%**		**11%**	

	Full Black			
	A0	400	**R0**	14.8
	A1	360	**R1**	13
	A2	325	**R2**	11
First	**19%**		**26%**	
Second	**9%**		**14%**	

< 30

< 15

All 3 samples passed above tests (specially scratched one)

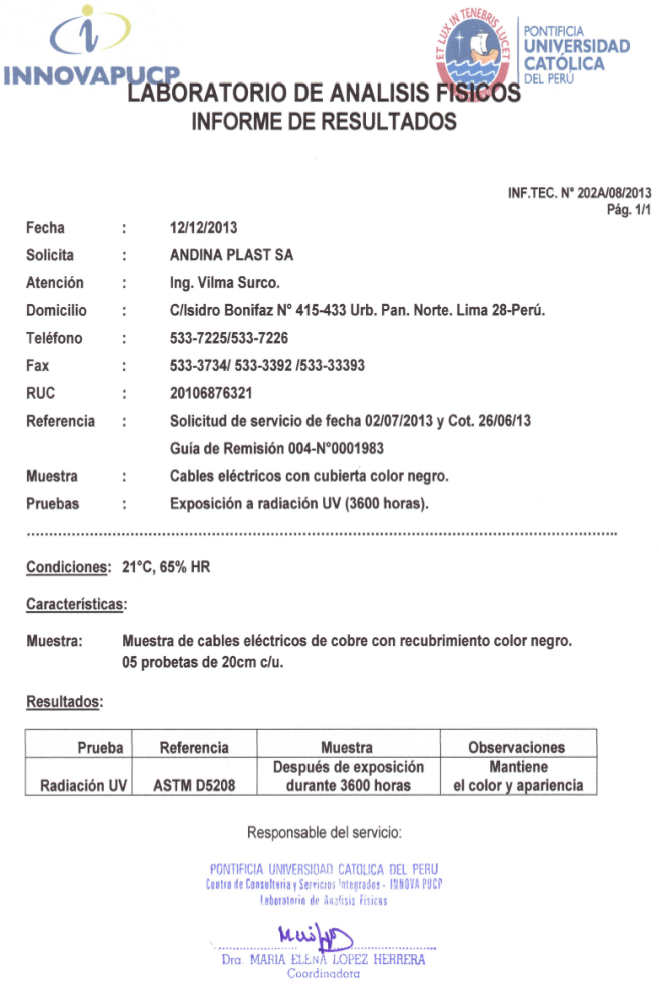
ANOTHER EXAMPLE

A SKIN Cable made in KENYA has been tested in Peru for UV protection

Test Standard : ASTM S5208

Test Duration : 3600 hours

Test Condition : 21'C , 65% HR



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LABORATORIO DE ANALISIS FISICOS
INFORME DE RESULTADOS

INF.TEC. N° 202A/08/2013
Pág. 1/1

Fecha	:	12/12/2013
Solicita	:	ANDINA PLAST SA
Atención	:	Ing. Vilma Surco.
Domicilio	:	C/Isidro Bonifaz N° 415-433 Urb. Pan. Norte. Lima 28-Perú.
Teléfono	:	533-7225/533-7226
Fax	:	533-3734/ 533-3392 /533-33393
RUC	:	20106876321
Referencia	:	Solicitud de servicio de fecha 02/07/2013 y Cot. 26/06/13
		Guía de Remisión 004-N°0001983
Muestra	:	Cables eléctricos con cubierta color negro.
Pruebas	:	Exposición a radiación UV (3600 horas).

Condiciones: 21°C, 65% HR

Características:

Muestra: Muestra de cables eléctricos de cobre con recubrimiento color negro.
05 probetas de 20cm c/u.

Resultados:

Prueba	Referencia	Muestra	Observaciones
Radiación UV	ASTM D5208	Después de exposición durante 3600 horas	Mantiene el color y apariencia

Responsable del servicio:

PONTIFICIA UNIVERSIDAD CATOLICA DEL PERU
Centro de Consultoría y Servicios Integrados - INNOVA PUCP
Laboratorio de Análisis Físicos

Dra. MARIA ELENA LOPEZ HERRERA
Coordinadora

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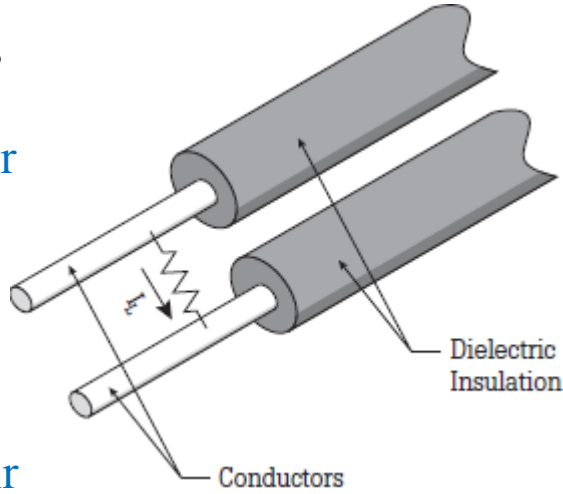
INSULATION RESISTANCE

We have applied 500 V D.C for Megger test in following conditions

A) Cores in Water – Voltage applied between Conductor and water

Black Skin / Natural Core R > 20 x 10^6 MOhms.KM

Whole Black Core R > 13 x 10^6 MOhms.KM



B) Bunched cable – Voltage applied between Conductors in the air

Black Skin / Natural Core R > 13 x 10^6 MOhms.KM

Whole Black Core R > 9 x 10^6 MOhms.KM

- **Conclusion :**

Insulation resistance in Black Skin / Natural Core is about 50 % more than Whole Black core . Meaning higher Dielectric Strength and more Cable life cycle.

CONCLUSION

We believe that in using a **fortified skin** layer, a cable company will not only save money but also allows for the production of a cable that has superior mechanical, thermal and electrical properties, without comprising on production speeds and surface finishes.

Any Questions

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