Case Study: Evaluation of DEICOPVCT910 on Small Cross Section

Abstract: This case study explores the application of DEICOPVCT910 compound in the cable industry and its impact on cable performance. The study focuses on the use of this and similar compound in the production process of smaller cable cross-sections <16mm^2.

Introduction: Many cable manufacturers could face challenges while processing these type of compound on smaller cross-sections and requires to go through extensive trial process by changing the parameter, hit and try and adapting various methodologies hence result in a huge cost to the company and time which results in loss of business, decrease in quality, on time performance and project penalties.

This case study therefore give brief best practice that needs to be adapted to achieve results without going into several Research and Development time consuming cycles.

Methodology and Process Technique: This research focuses on the best process control that are required in the smooth production of this type of material and satisfy all the specification's requirement of Type 9 in accordance with BS 7655 -4.2 and ST2 as per IEC 60502-1 and 2.

Before Manufacturing Process: Ensure the packaging is all intact, no moisture ingress in the compound and in case of doubt, predry the compound for 6 hours at 70^{o}C in a dehumidifying unit.

Manufacturing Process:

Extruder: 120mm

Extruder cleanliness checklist

Hopper	Barrel	Screw	Head	Die
✓	✓	✓	✓	✓

Checked each section of the extruder. Ensured the above areas were free from dust, contaminants, burnt particles and in excellent condition with no wear and tear on screw, head or die. Die selected in the process were high chrome polished.

Cable Size	4 x 10 mm^2		
Compound Color	Black		
Process Type	Tube sheathing		
Cable Inner Dimension	17.5	Cable Outer Dimension	19.5
Die Size 'mm'	27.5		
Tip Inner Dia 'mm'	21.0	Tip Outer Dia 'mm'	23.0

DD Ratio (DDR)	3.0	DD Balance (DDB)	1.0
Size of Mesh	60	Numbers of Mesh	1
Breaker Plate	Yes	Bypass	Yes
Screw Type	PVC	Screw Compression Ratio	2.5:1
Screw Cooling	Not used	Screw Cooling Temp(°C)	N/A

Water Bath temp (°C)	First Part	Second Part
	50°C	20°C

Process Profile Temperature (°C)

Profile	Extruder Barrel					Head and Die				
	Z 1	Z 2	Z 3	Z 4	Z 5	H 1	H 2	H 3	H 4	Die
1	120°C	130°C	140°C	150°C	160°C	170°C	170°C	180°C	180°C	185°C
2	130°C	140°C	150°C	160°C	170°C	170°C	180°C	180°C	180°C	185°C
3	**140°C**	**150°C**	**160°C**	**160°C**	**165°C**	**170°C**	**175°C**	**175°C**	**180°C**	**185°C**
4	145°C	155°C	165°C	165°C	165°C	175°C	175°C	175°C	180°C	185°C

After several trials, it was observed and concluded that **Profile 3** was the best match to process this type of compound.

Screw RPM	10	13	15	17	20
Melt Temp(C°)	175	178	182	185	190
Line Speed 'm/min'	25	30	35	40	46
Barrel Pressure 'Bar'	165	170	175	180	190
Length Produced 'm'	200	500	750	1000	50
Die Drool	No	No	No	No	No
Porosity	No	No	No	No	**Yes**
Spark Fault	No	No	No	No	No
Un-Melts	No	No	No	No	No
Surface Finish	Good	Good	Very Good	Excellent	**Poor**
Note	Melt temperature of this compound should not exceed 185°C for best results and it was seen in the trial that as the melt temperature was going beyod 185°C, small amount of porosity started to appear, and therefore sample was not taken.				

At Profile 3 and at set RPM of 17, almost 1 km of length was produced and found excellent surface finish on overall length with no apparent quality defect. Therefore sample was taken for type testing.

Below is the summary of type test results:

Test Performed	Unit	Specs	Observed				Result
Test for determining the mechanical properties of insulation Before and after Ageing							
Insulation							
Tensile Strength			Red	Yellow	Blue	Black	
Before ageing	N/mm²	12.5 (min)	16.02	17.85	16.81	16.00	Pass
After Ageing (135±3°C for 168hrs)		NA	13.98	14.77	13.73	14.41	
Variation	%	± 25	-12.73	-17.25	-18.32	-9.94	
Elongation at Break							
Before Ageing	%	200 (min)	332.54	380.75	347.17	337.9	Pass
After Ageing (135±3°C for 168hrs)		NA	308.87	317.73	302.34	309.0	
Variation	%	± 25	-7.12	-16.55	-12.91	-8.55	
Test for determining the mechanical properties of non metallic sheath. Bedding (Inner Sheath)							
Tensile Strength							
Before ageing	N/mm²	12.5 (min)	20.15				Pass
After Ageing (100±2°C for 168 hrs)	N/mm²	12.5 (min)	18.57				Pass
Variation	%	± 25	-7.84				Pass
Elongation at Break							
Before Ageing	%	150 (min)	226.07				Pass
After Ageing (100±2°C for 168 hrs)	%	150 (min)	188.30				Pass
Variation	%	± 25	-16.71				Pass
Test for determining the mechanical properties of non metallic sheath. Outer Sheath							
Tensile Strength							
Before ageing	N/mm²	12.5 (min)	20.89				Pass
After Ageing (100±2°C for 168 hrs)	N/mm²	12.5 (min)	18.72				Pass
Variation	%	± 25	-10.39				Pass
Elongation at Break							
Before Ageing	%	150 (min)	265.80				Pass
After Ageing (100±2°C for 168 hrs)	%	150 (min)	272.23				Pass
Variation	%	± 25	2.42				Pass
Additional Ageing test on pieces of completed cables *(100±2 °C for 168 hrs)*							
Insulation							
Tensile Strength	N/mm²	NA	19.63	16.28	18.16	15.20	Pass
Variation	%	± 25	22.53	-8.80	8.03	-5.00	

Elongation at break	%	NA	342.74	296.85	332.81	290.77	Pass
Variation	%	± 25	3.07	-22.04	-4.14	-13.95	
Bedding (Inner Sheath)							
Tensile Strength	N/mm²	12.5 (min)	20.60				Pass
Variation	%	± 25	2.23				Pass
Elongation at break	%	150 (min)	207.93				Pass
Variation	%	± 25	-8.02				Pass
Outer Sheath							
Tensile Strength	N/mm²	12.5 (min)	19.21				Pass
Variation	%	± 25	-8.04				Pass
Elongation at break	%	150 (min)	264.64				Pass
Variation	%	± 25	-0.44				Pass
Loss of mass in an air oven at 100°C ±2.							
Inner sheath	mg/cm²	1.5 (max)	0.09				Pass
Outer sheath	mg/cm²	1.5 (max)	0.196				Pass
Heat shock test at 150°C ±3	--	Shall not crack	No sign of cracks				Pass
Pressure test at high temp. on sheaths at 90±2°C.							
Depth of indentation (Inner sheath)	%	50 (max)	37.74				Pass
Depth of indentation (Outer sheath)	%	50 (max)	28.57				Pass
Test at low temperature on sheaths							
Inner sheath							
Cold elongation (-15±2°C)	%	20 (min)	122.13				Pass
Cold impact (-15±2°C)	--	Shall not crack	No sign of cracks				Pass
Outer sheath							
Cold elongation (-15±2°C)	%	20 (min)	136.03				Pass
Cold impact (-15±2°C)	--	Shall not crack	No sign of cracks				Pass
Hot set test on XLPE insulation		**(200±3 °C)**					
Elongation under load	%	175 (max.)	60	65	55	55	Pass
Permanent elongation after cooling	%	15 (max.)	0	0	0	0	Pass
Water absorption test on XLPE insulation at 85°C for 14 days							
Loss of mass	mg/cm²	1 (max.)	0.00	0.0001	0.00	0.00	Pass
Shrinkage test for XLPE insulation at 130±3°C for 1 hrs							
Shrinkage	%	4 (max)	1.50	1.75	1.50	1.40	Pass
Additional checks for cable construction Armour wire							
Diameter of armour wire	mm	2.00 (nom)	1.971 to 1.988				Pass
Mass of zinc coating (as per BS 5467)	g/m²	180 (min)	237 to 300				Pass
Armour resistance (as per BS 5467)	Ω/km	1.10 (max)	1.01				Pass
Over all Diameter (mm)	mm	19.5 ± 1	19.6				Pass

Results: The PVC compound production process resulted in significantly smooth processing by following the above techniques and selected profile. This type of compound provided excellent sheathing properties, enhanced mechanical strength of the cable and satisfying all parameters with excellent safety margin.

Discussion: The case study highlights the positive impact of this type of PVC compound on cable performance in the cable industry on 120mm extrusion line. The above proven profile not only improved the overall quality of the cables but also increased customer satisfaction. Our experience showed us a decrease in cable failures and an increase in the lifespan of the cables by following this profile on this material and therefore leading to improved reliability and customer satisfaction.

Conclusion: This case study demonstrates the effectiveness of DEICOT910 compound in enhancing cable performance in the cable industry. The successful evaluation of this type of PVC compound resulted in improved insulation integrity, better protection, and increased mechanical strength of the cables. This case study serves as a valuable reference for other cable manufacturers considering the use of thPVC compound in their production processes.