Cables with smooth welded aluminum sheath.

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ABSTRACT

The metallic sheath plays a key role in the design of High Voltage underground cable systems, as it must satisfy essential electrical and mechanical functions to ensure the correct operation of a cable.

Cables with lead alloy sheath provide all necessary guarantees in terms of technical characteristics. However, the main disadvantages of cables with a lead alloy sheath are weight.

On the other hand, cables with corrugated aluminium sheath have a significantly reduced weight when compared with cables having a lead alloy sheath. But, it has the disadvantages of not only a lower transmission capacity, due to the presence of an air gap under the corrugations. Also a larger diameter and accordingly shorter delivery lengths.

For that reason, we developed manufacture the mass of cables having smooth welded aluminium sheath.

KEYWORDS

Smooth welded sheath, Metallic sheath, Special process, Short circuit requirement

1. Introduction

Most HV cable systems are custom designed to suit also the specific environmental parameters and operating requirements of a particular route and loading conditions. Cables with smooth welded aluminium sheath is minimized other type metallic sheath(lead alloy sheath, corrugated sheath) disadvantages, resulting in a cable with lighter weight, reduced diameter and bending radius with a comparative longer length. The application and welding of the aluminium tape and the extrusion of the polyethylene are carried out through a special process on the same line, which undergoes continuously video recorded inspection ensuring effective quality control.

Extensive tests have proven that the water tightness and resistance to corrosion of the smooth welded aluminium sheath cable meets the most stringent standards. Depending on the short circuit requirements, the welded aluminium sheath can be complemented with copper wires.

In this paper, we deal with production and certification of smooth sheath cables.

The illustrated in Fig.1 show in section for cables.

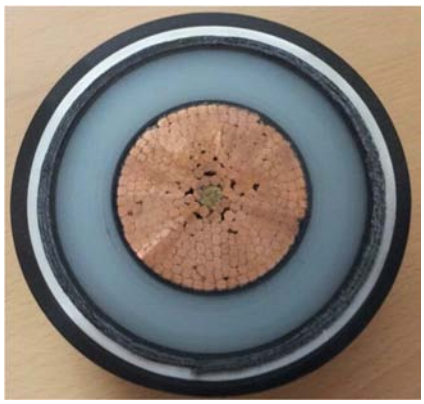

Fig 1. Cables with smooth welded aluminium sheath

2. Development of smooth welded cable

2.1 Manufacture process

Basically, there is a different manufacture process between smooth welded and corrugation welded, lead alloy welded.

This facility is consists of P/O, strip tool, extruder for adhesive PE, extruder for inner or outer sheath, T/U.

It means metal sheath and outer sheath have a special process on the same line. If metallic sheath and extrusion line process operate individually, wrinkle is generated at surface of metal sheath by winding cable. In order to prevent wrinkle occurrence, cable drum design is important. So we design over 21times of drum longitude multiple. Typically, drum longitude multiple is over 18times for other type sheath cable.

Fig 2. Strip tool for smooth welded metal sheath

For the reliable quality cable, eddy-current instrument is essential. This device can check welding condition of metallic sheath. Also, metal and outer sheath are to be adhesive. Because of that, the extruder for adhesive PE is located between strip tool and extruder for outer sheath.

Fig 3. Eddy-current

2.2 Construction of each completed cable

Cable cost down is possible through smooth welded sheath compare with other type sheath. By remove the gap between insulation screen and metal sheath, cable diameter should be reduced and increased delivery lengths.

Table 1 is showing the main Constructions of each cable with rated voltage 400 kV.

Table 1. Constructions cable

Description		Unit	Curr-gation	Smooth
Rated voltage		kV	400	400
Conductor	Material	-	Cu	Cu
	Area	mm^2	2500	2500
	Shape	-	Milliken	Milliken
	Outer dia. with tape	mm	62.4	62.4
Conductor Screen	Thickness	mm	1.5	1.5
Insulation	Thickness	mm	27.0	27.0
Insulation Screen	Thickness	mm	1.5	1.5
Binder tape	Thickness	mm	3.2	1.0
Metal sheath	Material	-	Al	Al
	Shape	-	Curr-gation	Smooth
	Thickness	mm	3.2	1.8
Outer sheath	Thickness	mm	6.0	6.0
Outer diameter		mm	161.4	144.4
Gross weight		kg/km	41319.7	36319.6

Example for two cables are same construction up to insulation process compare with diameter and weight.

3. Type Test on cable for smooth welded cable and accessories

3.1 400 kV 2500SQ Type test

Table 2. Consists of power system

Item	Product name
Cable	400 KV 2500SQ (Cu/XLPE/Smooth AL/PE)
Joint and termination	EB-A, EB-G, PMIJ

This test carried out in accordance with

-. System & cable test : IEC 62067

-. Corrosion test : IEC 61901

Korea`s first certification for smooth welded sheath cable

3.1.1 Bending test

A cable sample of approximately 140 meters was bent around a test cylinder with a maximum diameter of (36*(d+D)+5%), Hereafter the sample was unwound and bent in the reverse direction.

This procedure was carried out three times in total. The result is 3600mm (requirement : ≤7450 + 5%)

Fig 4. Bending test

3.1.2 Partial discharge test

After the bending test as described above 3.1.1, the accessories were mounted. The sensitivity of the measuring circuit was checked with calibrator, the maximum detectable pulse was 2.0 pC. The voltage was first set to 385 kV (1.75 Uo) for at least 10seconds and then lowered to 330 kV (1.5 U_o). At this voltage the partial discharge were measured.

Table 3. Result of partial discharge test

Item	Unit	Results	Requirements	Remarks
After the bending test	pC	≤ 1.95	≤ 5	Ambient temp.
After impulse test	pC	≤ 1.48	≤ 5	Ambient temp.
After impulse test	pC	≤ 1.49	≤ 5	100 ~105°C

3.1.3 Tan δ measurement

Before the heating cycle voltage test at 220 kV(U_o) at a steady conductor temperature of 100 ~ 105°C (+0, -5°C the emergency temperature)

The result is $0.52*10^{-4}$ (requirement : ≤ $10*10^{-4}$)

3.1.4 Heating cycle voltage test

The test loop was subjected to a power frequency test of $2U_o$ (440kV), 60 Hz for at least 2592 hours. During this test, the test loop was subjected at least 108 heating cycles. Each heating cycle consisted of 8 hours heating and 16 hours of natural cooling. During the last 2 hours of each heating period the conductor maintained in the specified temperature limits of 105 ~ 110°C

Fig 5. Test loop set up

3.1.5 Switching, Lightning impulse voltage test

Switching impulse voltage was carried out while the conductor was heated to a temperature of 100 ~ 105℃. The conductor temperature shall be maintained within the stated temperature limits for at least 2 hours. The sample was tested with 10 positive and 10 negative voltage impulse of ± 1050 kV_P.

Lightning impulse was tested with 10 positive and 10 negative voltage impulse of ± 1425 kV_P

3.1.6 Power frequency voltage test

Upon completion of the impulse withstand voltage test, a voltage test was executed with an alternating voltage, 60 Hz. The test set-up was tested with a voltage of at least 440 kV ($2U_o$) for 15 minutes. The test was carried out while the test loop was at ambient temperature.

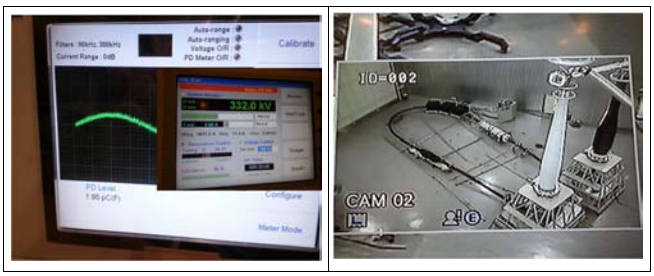

Fig 6. Impulse test

3.1.6 Examination

Upon completion of all tests, the test loop was dismantled. The cable and accessories were inspected for leakage, corrosion, electrical degradation and shrinkage that could affect the system.

Table 4. Result of examination

Item	Unit	Results	Require -ments
Number of wires in conductor Diameter of over conductor	Type Nominal Average	61*5seg - 61.88	61*5seg 61.2 -
Thickness of conductor screen	Nominal Average Minimum	 1.74 1.53	1.5 - ≥1.0
Thickness of insulation	Nominal Average Minimum	 26.97 26.36	27.0 - ≥24.3
Eccentricity of insulation layer	Maximum	3.69%	≤ 10%
Thickness of insulation screen	Nominal Average Minimum	- 1.57 1.47	1.5 - ≥1.0
Thickness of tape (water barrier)	Nominal Average	- 2.16	3.0 -
Thickness of Al smooth sheath	Nominal Average Minimum	- 1.95 1.90	1.8 - ≥1.61
Thickness of outer sheath	Nominal Average Minimum	- 7.04 6.98	6.0 - 5.0
Overall diameter	Nominal Average	- 144.5	144.4 -

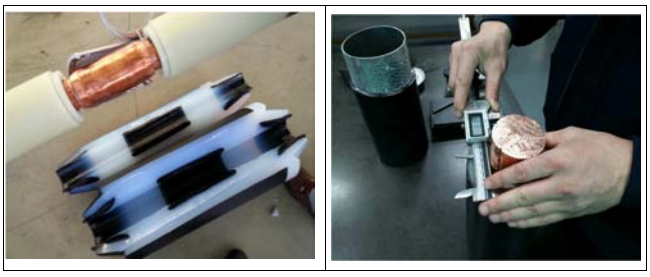

Fig 7. Examination test

4. Conclusion

We passed type test 400 kV cable system as above IEC 62067 and got a qualification of smooth welded cable to customers.

As mentioned above the section, this cables has lighter weight, reduced diameter and bending radius with a comparative longer length. Also guarantees excellent electrical and mechanical performance, full fluid tightness and compliance with even the strictest environmental requirements.

We are characterised by a competent and experienced approach to turnkey total solution for cable system include smooth metal sheath cables and we have a guarantee for the supply of products and service based on quality standards.

REFERENCES

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