Recent developments to improve the degassing and long run extrusion performance of HV cables

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ABSTRACT

The performance of extruded high voltage XLPE insulated cables can be improved through more efficient degassing and realization of longer extrusion run times. This development was focused on controlled extension of run time and reduced degassing burden. The synergistic interaction of the novel XLPE compound and the new screw design was confirmed via screw moulding extraction after completing the campaigns. As a result, the run time could be increased by 300% up to 3 weeks (140 ton of insulation XLPE) and the degassing time reduced to less than half. The quality of the last cable drum was confirmed in high stress electrical testing.

KEYWORDS:

Long run extrusion, XLPE, degassing, scorch

INTRODUCTION

The quality of extruded cable systems generally improves with the quality of the compound system, the continuous vulcanisation (CV) line with its extrusion and curing parameters, as well as the by-products level.

The traditional insulation systems were for a long time focused entirely on the electrical properties of the final cable. Cleanliness of the insulation and smoothness of the semi-conductive layers once extruded on the cable brought high AC breakdown strength and performance at high electrical impulse. The processing considerations were limited to balance crosslinking speed and scorch resistance.

The CV lines were standardized and focused on the same priorities. The melt filter (screens) selection in Europe has tended to employ coarse screens, partly in response to limitations of the compounds and/or extruders. The practice in the Far East to the contrary is normally to use dense screens. The common operating mode of cable producers has been to run the insulation process for 5 to 7 days. The limitation has often been pressure build up or scorch generation in stagnant points of the insulation screw. The tendency to scorch depends on the heat exposure of the insulation compound system and its scorch resistance. The key variables impacting heat exposure are residence time and melt temperature.

Over the last decade, XLPE compound suppliers have been putting increased efforts to improve processability and reduce degassing burden of XLPE.

Cable producers have still been hesitant to make significant extensions of run length due to the risk for scorch and failure in routine voltage testing. Although several lab methods have been suggested, it is commonly accepted that predicting the scorch formation in commercial cable production presents significant challenges.

For example, MDR TS_1 [1] at 140°C gives an indication of the relative heat stability of the compounds used but does not take into consideration the residence time of the compound in the extrusion process, The “Carrot Scorch Test” [2] is useful but requires much effort and is limited in its use to predict the actual run length.

Therefore, it was decided to conduct the extension in several steps during commercial cable production to prove the performance of the novel insulation XLPE as well as the screw geometry. The degassing speed was maximized by optimizing insulation formulations, processing parameters in CV line, as well as the degassing temperature.

EXPERIMENTAL

Baseline and Precautions

Extrusion run time is typically limited by a gradually increasing extrusion pressure as a result of some degree of scorch. As a result, degraded polyethylene can trigger failures directly or by causing extrusion irregularities. Several precautions were taken to limit this risk.

To accomplish a stable baseline of quality, all the long insulation campaigns were conducted on state-of-the-art VCV line designed up to 500 kV XLPE cable production. The VCV line operation is covered in more detail in an earlier presentation [3].

Furthermore, a low stress cable design, as in Table 1, was combined with fine mesh screens, and triggering points for actions at given pressure levels were set. The novel insulation XLPE and novel extruder modifications were confirmed in Type-Test according to IEC 60840.