# Investigation Life Time Model of 22 kV XLPE Cable for Distribution System Applications in Thailand

BOONRUANG MARUNGSRI, ANUCHA RAWANGPAI and NIMIT CHOMNAWANG High Voltage Insulation Technology Research Laboratory, Alternative and Sustainable Energy Research Unit School of Electrical Engineering, Institute of Engineering, Suranaree University of Technology Muang District, Nakhon Ratchasima, 30000, THAILAND Email : bmshvee@sut.ac.th

Abstract: - Cross-linked polyethylene (XLPE) high voltage cables have been widely used in power transmission and distribution systems. Ageing deterioration of XLPE insulating material can not be avoided because it is made of polymeric material. This paper present results of artificial ageing test of 22 kV XLPE cable for a distribution system application in Thailand. XLPE insulating material of 22 kV cable was sliced to 60-70  $\mu$ m in thick and subjected to AC high voltage stress at 23°C, 60°C, 75°C and 90°C. The specimens were tested under different electrical stress levels varying from 50kV/mm to 130kV/mm. Testing voltage was constantly applied to the specimen until breakdown. Five specimens were tested at each temperature and voltage stress level. Breakdown voltage and average time to breakdown were used to evaluate life time of insulating material. Furthermore, the physical model by J. P. Crine for prediction life time of XLPE insulating material was adopted as life time model and was determined in order to compare with the experimental results. In addition, Fourier transform infrared spectroscopy (FTIR) for chemical analysis and scanning electron microscope (SEM) for physical analysis were conducted on the tested specimens.

*Key-Words:* - Artificial accelerated ageing test, XLPE cable, distribution system, insulating material, life time, life time model

## **1** Introduction

Recently, high voltage (HV) cables are widely used for transmission and distribution networks. Cross-linked polyethylene (XLPE) is common for HV cables insulating material. XLPE material contains cross-linked bonds in the polymer structure, changing the thermoplastic to an elastomeric. XLPE has good electrical properties and can operate in high temperature. XLPE insulated cables have a rated temperature of 90 °C and an emergency rating up to 140°C, depending on the standard used. XLPE has excellent dielectric properties, making it useful for medium voltage, 10 to 50 kV AC, and high voltage cables, up to 380 kV AC, and several hundred kV DC. Although XLPE having good dielectric properties for high voltage applications, ageing of XLPE material can not be avoidable after long time in service under various stress. Furthermore, condition monitoring for XLPE high voltage cable was performed by many researchers in order to monitor the degradation of XLPE insulating material[1,2,3]. In addition, XLPE insulated cable models for high voltage applications have been studied and investigated in order to

evaluate a function of service stresses and ageing time. In order to improve the dielectric performance of XLPE material, many researchers attempted to improved XLPE properties [4], such as increased thermal and mechanical properties [5], detected damage by water treeing in the cables [6], and studied multifactor ageing proposed mathematical models based on experimental conditions of XLPE [7]. Several life models are proposed in order to evaluate a function of service stresses and ageing time, such as the exponential model introduced by Fallou[7], the inverse power law [7], the probabilistic model introduced by Montanari [7],[8], and the physical model introduced by Crine [7], [9].

In Thailand, voltage levels for distribution networks of Provincial Electricity Authority (PEA) are 22 and 33 kV. Overhead line and underground XLPE cables are usually used in PEA distribution networks. However, a function of service stresses and ageing time of underground XLPE cable has been no studied. By this reason, the accelerated ageing test has been conducted on 22 kV underground XLPE cables in order to determine a function of service stresses and ageing time. Furthermore, life time model proposed by Crine is adopted as the mathematical model to analyze the experimental results.

## **2** Insulation Ageing

Generally in services, an insulation system subjected to one or more stress that causes irreversible changes of insulating material properties with time. This progressively reduces the attitude of insulation in enduring the stress itself. This process is called ageing deterioration and ends when the insulation is no longer to withstand the applied stress. The relevant time is the time-to-failure or time-to-breakdown, alternatively called insulation life time [10]. The main causes of ageing of polymeric cables [5] are:

(1) Thermal degradation.

(2) Partial discharges due to manufacturing imperfections or to mechanical damage.

(3) Water trees, i.e. tree-like micro-cracks that grow from internal defects when the insulation is subjected to electrical stress and moisture.

(4) Aggression by the environment.

(5) Losses.

## **3 Ageing Models**

Although many models and theories have been proposed for ageing of insulating material but few are reliable, mainly due to they are unable to describe all the interactions among the various parameters. Insulation life time modeling consists of looking for adequate relationships among insulation life time and the magnitude of the stress applied to it. In the case of electrical insulation for polymeric high voltage cables, the stresses most commonly applied in service are an electric field due to voltage, temperature and loss, however other stresses, such as mechanical stresses (bending, vibration) and environmental stresses (such as pollution, humidity) can be presented.

A physical life model is one of ageing models that its model parameters can be estimated only after life tests, often lasting for a very long time. The search for physical models, based on the description of specific degradation mechanisms assumed as predominant within proper ranges of applied stresses. Such models are characterized by physical parameters that can be determined by direct measuring physical quantities. Some examples of physical models are described as follows.

#### **3.1 Field Emission Model**

This model is based on the physical damage produced by charge injection in the insulating material, thus it holds for high electric field values. The model can be represented by the following equation [11].

$$t_I = \frac{C}{A_I} \left[ exp\left(\frac{-B_I \phi^{3/2}}{E}\right) - exp\left(\frac{-B_I \phi^{3/2}}{E_T}\right) \right]^{-1}$$
(1)

where

 $t_I$  is electrical treeing inception time (however,  $t_I$  does not always coincide with life because time to failure is composed by treeing induction and treeing growth time)

*C* is the critical energy level that charges injected into the insulation must exceed to contribute to tree initiation.

 $B_I$  and  $A_I$  are material constants.

 $\phi$  is the effective work function of the injecting electrode.

E is apply electrical stress

 $E_T$  is threshold electrical stress

#### **3.2 Treeing growth model**

This model is used to describe the treeing growth period before permanent failure of insulating material. Many researchers have been proposed mathematical equations for such period. Some examples are given as follows.

#### (i) Bahder's Model

This model proposed by Bahder et al.[12]. The model is based on treeing growth period time and it can be expressed as in equation (2)

$$t_G = \frac{1}{fb_1 \{ exp[b_2(E - E_T)] - 1 \} [exp(b_3 E - b_4)]}$$
(2)

where

 $t_G$  is the treeing growth period time

 $b_1$ ,  $b_2$ ,  $b_3$ ,  $b_4$  are constants which depend on properties of material, temperature and geometry.

f is the frequency of the applied electrical stress.

*E* is the applied electrical stress

 $E_T$  is the threshold electrical stress

#### (ii) Dissado's Model

This model proposed by Dissado et al.[13]. They proposed the treeing growth period time as similar as the model introduced by Bahder et al. The model can be described by the expression as follows.

$$t_G = \frac{S_C(1/2f)N_C}{\{[exp(L_b\alpha_T(E))] - 1\}^{-1}}$$
(3)

where  $t_G$  is the treeing growth period time

*d* is the fractal dimension of tree,

 $S_C$  is the number of tree branches at failure,

 $L_b$  is the tree-branch length,

 $\alpha_T(E)$  is the first Townsend coefficient

 $N_C$  is the material constant;

f is the frequency of applied electrical stress

#### (iii) Montanari 's Model

Montanari proposed time to failure model which initiates by electrical treeing[14]. Tree-growth phenomenology and space charge entering to the treeing path are taking into account. The model can be described by the expression as following.

$$t_F = \frac{\left((1/k_1)\ln[(Q_m/k_2) + 1]\right)^d}{k_5(E - E_T)^n}$$
(4)

where  $t_F$  is the time to failure

 $k_5 = f(k_1, k_2, k_3, k_4)$ 

 $k_1$ ,  $k_2$ ,  $k_3$  and  $k_4$  are coefficients depending on material and tree-growth phenomenology,

 $Q_m$  is the maximum amount of space charge entering the channels at depth of penetration  $x_m$ ;

#### 3.3 Thermodynamic Model

The concept of this ageing model is that thermally-activated degradation reactions cause material ageing. Such reactions carry the moieties that undergo degradation, e.g. polymer chains or monomers from reactant to degraded state, through a free energy barrier. The energy needed to overcome the barrier height,  $\Delta G$ , is dependent on temperature. The applied electric field plays the role of lowering the barrier in different ways, depending on the approach proposed. Some existing of thermodynamic models are given as follows.

#### (i) Crine's model.

This model is proposed by Crine et al. [15]. The concept of the model is that an electric field stress accelerates electrons(*e*) over the so-called scattering distance ( $\delta$ ) so that they gain a mean energy  $e\delta E$  that lowers the barrier. The model can be expressed as:

$$t \propto (h/2kT) exp(\Delta G/kT) csc h(e\delta E/kT)$$
(5)

where k and h are the Boltzmann and the Planck constants. Equation (5) provides electrical life lines at a chosen temperature which are straight at high stresses in semi-log plot, tending to infinite life when  $E \rightarrow 0$ .  $\delta$  is shown to be a temperature dependent quantity and should be linked to microstructural characteristics of the material (e.g., the dimensions of amorphous regions between crystalline lamellae in Polyethylene) and to the size of submicrocavities that progressively grow in the material due to weak bond-breaking by accelerated electrons [16]. In fact, this involves that the model is not fully explained as a function of temperature and time. Hence, it can fit electrothermal life test results, but its estimates cannot be extrapolated at temperatures different from the test ones, as can be done by fully-explicit electrothermal life models. In addition, the model postulates that electrons are enough accelerated to gain the energy needed to break weak bonds: this may involve the presence of sufficiently-large microvoids from the very beginning of ageing process, or of high electric fields [17-19].

#### (ii) Lewis's Model

This model have been proposed by Lewis et al. [20]. The model is based on the formation of microvoids by means of chemical bond-breaking processes induced by voltage and temperature. Some of such microvoids can coalesce into larger voids. As soon as sufficiently large voids are formed, a crack can start and ultimately breaks the insulation. Hence, according to Griffith criterion for crack propagation, the time needed to initiate crack growth,  $t_c$ , (which is assumed as predominant during a whole ageing time) is obtained as:

$$t_{C} = \int_{N}^{\eta_{C}} \left\{ \frac{kT}{h} \left[ exp\left( \frac{-Ur(E)}{kT} \right) (N - \eta) - exp\left( \frac{-Ub(E)}{kT} \right) \eta \right] \right\}^{-1} d\eta$$
 (6)

where  $\eta$  is the number of broken bonds,  $\eta_C$  is the critical number of broken bonds, *N* is the number of breakable bonds, Ur(E) and Ub(E) are the energies needed for bond forming and breaking, respectively.

#### (iii) Space-charge model

This model have been proposed by Dissado, Mazzanti and Montanari [21]. Their assumption is that space-charges injected by electrodes and/or impurities and trapped within the insulation are responsible for electromechanical energy storage that, in turn, lowers the energy barrier, thus favoring degradation. The higher the electrical field stress, the higher the stored charge and energy, hence the lower the life. After some simplifying hypotheses and proper rearrangements, the model is obtained in the following form:

$$t_{C} = \frac{kT}{h} exp \left[ \frac{\Delta H}{k} - \frac{C'E^{2b}}{2}}{kT} - \frac{\Delta S}{k} \right] \left[ ln \left( \frac{A_{eq}(E)}{A_{eq}(E) - A^{*}} \right) \right] \left[ cosh \left( \frac{\Delta H}{k} - \frac{C'E^{2b}}{2}}{kT} - \frac{\Delta S}{k} \right) \right]^{-1}$$

$$(7)$$

where  $A_{eq}(E)$  is the equilibrium value of A, the conversion rate of moieties from state 1 to 2. Other quantities introduced in equation (7) are defined as follows.  $A^*$  is the critical limit of A (when exceeded, failure is said to take place); C' and b are material constants. H and S are enthalpy and entropy per moiety.  $\Delta H = H_a - (H_1 + H_2)/2$  and  $\Delta S = S_a - (S_1 + S_2)/2$  are enthalpy and entropy contributions of activation free energy per moiety. Subscripts 1, a, and 2 are relevant to ground, activated and degraded states, respectively. At beginning, the model in equation (7) is used for DC voltage only. However, the model can be extended to AC voltage by splitting activation entropy and enthalpy to a DC part plus an AC contribution [22].

## **4 Crine's Model Implementation**

According to the model proposed by Crine et al. which is already addressed in the previous section, an application of the model to predict life time of XLPE insulating material for high voltage cable is implemented in this section. However, theoretical explanations are illustrated in [8,9,23,26]. This model is based on two parameters, the activation energy,  $\Delta G$ , and activation volume,  $\Delta V$ . The assumption is that an electrical ageing is a thermally activated process with an activation energy  $\Delta G = \Delta H$ - $T\Delta S$ , where  $\Delta H$  and  $\Delta S$  are the activation enthalpy and entropy, respectively. It described the ageing process of electrical insulation (XLPE) by reducing the height of the energy barrier controlling the process. When the time to go over barrier is the inverse of the rate, time t to reach the aged state is given by

$$t = \left[\frac{h}{2fkT}\right] \cdot exp\left(\frac{\Delta G}{kT}\right) \cdot csc h\left(\frac{1}{2} \cdot \frac{\varepsilon_0 \varepsilon' \Delta V F^2}{kT}\right)$$
(8)

This equation is well described the ageing results of XLPE by the linear relation at high fields. Considering predicted times at zero field in equation (8), t will be equal to infinity since csch (0) = $\infty$ . Thus, there will be some sort of tail at low field, where t will slowly goes toward  $\infty$ . At high field, equation (1) can be reduced to

$$t = \left[\frac{h}{2fkT}\right] \cdot exp\left[\frac{\Delta G - \frac{1}{2}\varepsilon_0 \varepsilon' \Delta V F^2}{kT}\right]$$
(9)

where

 $\varepsilon_0$  is  $8.85 \times 10^{-12}$  F/m

 $\varepsilon'$  is the relative permittivity of XLPE = 2.5

- *h* is the Planck's constant =  $6.626068 \times 10^{-34}$
- $m^2$ .kg/s
- k is the Boltzmann's constant =  $1.3806503 \times 10^{-23}$
- $m^2 kg s^{-2} K^{-1}$
- F is the applied voltage (kV)
- T is the temperature (K)
- f is the frequency (Hz)

As illustrated in equation (9), the activation energy,  $\Delta G$ , and the activation volume,  $\Delta V$ , are unknown variable. However,  $\Delta G$  and  $\Delta V$  can be directly obtained from the experimental results in a linear relation between  $F^2$  and log t. In order to find such a linear relation, a logarithmic function is applied to the both side of equation (9), as illustrated in equation (10).

$$log(t) = log\left[\frac{h}{2fkT}\right] + log\left[exp\left(\frac{\Delta G - (1/2)\varepsilon_0 \varepsilon' \Delta V F^2}{kT}\right)\right] (10)$$

By rearranging the equation (10), equation (11) is derived.

$$log(t) = log\left[\frac{h}{2fkT}\right] + log\left[exp\left(\frac{\Delta G}{kT}\right)\right] + log\left[exp\left(-\frac{\varepsilon_0\varepsilon'\Delta VF^2}{2kT}\cdot F^2\right)\right]$$
(11)

Finally, equation (12) is obtained.

$$log(t) = \left[ log\left(\frac{h}{2fkT}\right) + \left(\frac{\Delta G}{kT}\right) \right] + \left(-\frac{\varepsilon_0 \varepsilon' \Delta V}{2kT} \cdot F^2\right) \quad (12)$$

An empirical form of equation (12) is y = -ax+b, where *a* is the slope and *b* is the intercept. Considering the experimental data,  $\Delta G$  can be obtained from the slope at the high filed region and  $\Delta V$  can be obtained from the intercept. Both parameters depend on the size of the specimen.

### **5** Accelerated Ageing

The accelerated ageing is the degrading stresses of insulation material, such as electrical stress, thermal stress, mechanical stress, and environmental stress. The accelerated ageing employs commonly used multi-stresses [7] (double or triple stresses). The multi-stresses are electrical - thermal stress and electrical – mechanical stress.

There are several methods to accelerate the ageing process [7], [24-25]. But the most popular one is experimental performed on insulation material at voltages and temperatures higher than normal operating conditions. There are two methods of applying the voltage stress. The first method is that the voltage is held constant until the sample aged and breakdown. In the second method, the voltage stress is increased in steps until sample aged and breakdown. In both methods, when breakdown occurred, time to failure for calculation life models is observed. In our experiment, the first method (constant voltage stress) was conducted.

The main goal of ageing models is to establish a relationship for the ageing process and the stresses causing it. The models are done through an accelerated process. The most popular one is an experiment on insulation at voltages much higher than normal operating conditions of cables, at constant frequency. This paper adopted the Crine's model for describing and proving the experimental results from accelerated ageing test of XLPE insulating material.

## 6 Experimental

The specimens for experimental are made from unaged 22 kV XLPE distribution power cables having aluminum conductors 17 mm in diameter and XLPE insulation 3 mm of thickness, as shown in Fig. 1. This type of power cables is used in underground distribution system of Provincial Electricity Authority (PEA) of Thailand. A number XLPE of 1-cm wide ribbons at thickness 60-70µm were cut by a microtome from the insulation around a cables. All specimens were measured precisely before testing so the thickness effect is neglected. The accelerated ageing test chamber consists of a pair of solid stainless cylinders, the lower grounded one is 30 mm in diameter and the upper-high voltage electrode is 10 mm in diameter, which was connected to a 50 Hz testing transformer. Furthermore, heater and temperature sensor are included for heat generation and temperature control. Afterwards placing the specimen between the electrodes, the electrodes were immersed in transformer oil in order to avoid surface flashover in air. Detail of the test chamber is illustrated in Fig. 2. The experimental diagram is shown in Fig. 3 and

experimental layout is shown in Fig. 4

The Experimental were conducted at temperatures 23 °C, 60 °C, 75 °C and 90 °C. In addition, the specimens were tested under different electrical stress levels varying from 50 kV/mm to 130kV/mm, as shown in Table 1.



Fig. 1 22kV cables section schematic.



Fig. 2 Accelerated Ageing Test Chamber

As illustrated in Fig. 3, timer unit was used to measure time to breakdown of the specimen. At the moment of the electrical and thermal stresses applying to the specimen, the timer unit starts record the life time or breakdown time. Once the breakdown occurs, the relay trips automatically and the timer stops. Then, the breakdown time is recorded for analysis. For each breakdown voltage level, five specimens were tested. Once the tests were complete for a data set, the data points were averaged to obtain data representative.



Fig. 3 Experimental Diagram



Fig. 4 Experimental Layout

E	Tested Voltage Stress Level					
(K V/IIIII)	23 °C	60 °C	75 °C	90 °C		
50	Х	Х	Х	0		
75	Х	Х	0	0		
90	0	0	0	0		
100	0	0	0	Х		
110	0	0	Х	Х		
120	0	0	Х	X		
130	0	Х	Х	Х		

 Table 1 Voltage Stress Levels for the Experimental

O : Tested level X : Un - tested level

## **7 Experimental Results and Discussion**

The experimental were carefully conducted in order to obtain the precisely results. Experimental results, time to failure or time to breakdown of the specimen, are illustrated in Table 2.

Table 2 Experimental Results

E (kV/mm)	Average Time to Failure of Tested					
	Specimens (sec)					
(k v/mm)	23 °C	60 ∘C	75 ∘C	90 ∘C		
50	-	-	-	2,178.3		
75	-	-	1373.5	112.3		
90	25,200	5973.7	400.8	7		
100	3,120	778.2	12	-		
110	476	81.8	-	-		
120	61.5	7	-	-		
130	8	-	-	-		

In order to calculate  $\Delta V$  and  $\Delta G$ , the experimental results at temperatures 23 °C, 60 °C, 75 °C and 90 °C form the accelerated ageing test in Table 2 were plotted in a semi-logarithm graph. Then a linear relationship between F<sup>2</sup> and log *t* is obtained by using a linear fitting technique, as shown in Fig. 5, Fig. 6 and Fig. 7, respectively.







Fig. 8 A Linear Relationship Between  $F^2$  and log t at 90 °C

By using the linear fitting technique, the linear relationship between the square of electric field stress,  $F^2$ , and log *t* can be determined in term of y=-ax +b, while  $y = \log t$ ,  $x = F^2$ , a = slope and b = intercept, respectively. Parameters from the linear fitting technique, as illustrated in Table 3, were used to determined  $\Delta V$  and  $\Delta G$ . According to equation (12),  $\Delta V$  and  $\Delta G$  can be determined by the following expression.

$$\frac{\varepsilon_0 \varepsilon' \Delta V}{kT} = a \tag{13}$$

$$\Delta V = \frac{akT}{\varepsilon_0 \varepsilon'} \tag{14}$$

$$\log\left(\frac{h}{2fkT}\right) + \frac{\Delta G}{kT} = b \tag{15}$$

$$\Delta G = kT \left( b - \log \left( \frac{h}{2fkT} \right) \right) \tag{16}$$

The obtained results,  $\Delta V$  and  $\Delta G$ , are illustrated in Table 4. Temperature dependent of obtained results can be observed. Finally, Crine's models from the experimental results are obtained according to equation (9). By the obtained Crine's model, life time of XLPE insulating material can be calculated. The calculation results are shown in Table 4. The calculation results, time to failure, from Crine's model agree with the experimental results.

In order to confirm the accuracy of Crine's model, life times from the experimental and from Crine's model are plotted in the semi-logarithm axes, as shown in Fig. 9, Fig. 10, Fig. 11 and Fig. 12, respectively.

Table 3	Parameters	from	the	linear	fitting	techniq	ue

Parameters	Experimental Results (sec)				
	23 °C	60 ∘C	75 ∘C	90 ∘C	
a	$9.0828 \times 10^{-10}$	$1.027 \times 10^{-9}$	1.0546×10 <sup>-9</sup>	1.218×10 <sup>-9</sup>	
b	17.281	17.384	13.575	10.311	

Parameters -	Experimental Results (sec)				
	23 °C	60 ∘C	75 ∘C	90 ∘C	
$\Delta V [m^3]$	3.26×10 <sup>-25</sup>	4.46×10 <sup>-25</sup>	4.58×10 <sup>-25</sup>	4.63×10 <sup>-25</sup>	
$\Delta G$ [J]	$2.09 \times 10^{-19}$	2.37×10 <sup>-19</sup>	$2.30 \times 10^{-19}$	2.23×10 <sup>-19</sup>	

Table 4 Parameters of the the Crine's Model

E	Crine's Model Results (Sec)					
kV/mm	23 °C	60 °C	75 °C	90 °C		
	-	-	-	2,336.7		
75	-	-	2085.7	95.9		
90	18,944	4780	153.4	7.6		
100	3,533	1200	20.7	-		
110	552	65.5	-	-		
120	72	7	_	-		
130	8	-	_	-		

Table 5 Life Time Results from the Crine's Model



Fig. 9 Comparison Life Time from Experimental and the Crine's Model at 23°C



Fig. 10 Comparison Life Time from Experimental and the Crine's Model at 60°C



Fig. 11 Comparison Life Time from Experimental and the Crine's Model at 75 °C



Fig. 12 Comparison Life Time from Experimental and the Crine's Model at 90  $^\circ$ C

In order to compare the effect of temperature, experimental results and time to failure from Crine's model for each temperature level were plotted together in semi-log scale, as shown in Fig. 13. As illustrated in Fig. 13, time to failure of tested specimen decreases with increase of the temperature. For physical damaged observation, tested specimen surface observation by using the microscope was performed. Examples of physical damaged observation are shown in Fig. 14 - Fig. 17. Carbon from carbonization was observed at the damaged point.



Fig. 13 Comparison time to failure from experimental results and Crine's model



Fig. 14 Surface Damaged due to Electric stress 90 kV/mm at 23  $^\circ\mathrm{C}$ 



Fig. 15 Surface Damaged due to Electric stress 90kV/mm at 60  $^\circ C$ 



Fig. 16 Surface Damaged due to Electric stress 90kV/mm at 75  $^\circ\mathrm{C}$ 



Fig. 17 Surface Damaged due to Electric stress 90kV/mm at 90  $^\circ\mathrm{C}$ 

In addition, chemical analysis was performed by the Fourier transform infrared spectroscopy (FTIR) for un-aged and aged specimens. Furthermore, surface damaged observation results agree with chemical analysis results. For XLPE insulating material, C=C peaks at 1610 cm<sup>-1</sup> appeared for aged specimen [27]. As illustrated in Fig. 18 for unaged specimen and Fig. 19 for aged specimen at 23 °C, C=C peaks at 1610 cm<sup>-1</sup> is only observed on FTIR result of the aged specimen comparing with the unaged specimen. Appearing of C=C peaks at 1610 cm<sup>-1</sup> confirmed carbonization process due to ageing process. After well conducting the experiment and carefully analyzing the experimental results, very acceptable results in the life time from the Crine's model were obtained when comparing with the experimental data. However, the accuracy of the experimental results depends on the precise thickness of specimens, voltage stress stabilization and accuracy of a temperature control unit.



Fig. 18 Chemical Analysis by FTIR for Unaged Specimen



Fig. 19 Chemical Analysis by FTIR for Aged Specimen

## **8 CONCLUSION**

The accelerated ageing test of XLPE insulating material from 22 kV high voltage cable was conducted. Four temperature levels, 23°C, 60°C, 75°C and 90°C, and electrical stress between 50 -130 kV/mm were test conditions. Electrical stress and time to breakdown were used to evaluate the life time of insulating material. The Crine's model parameters,  $\Delta V$  and  $\Delta G$  values, were obtained from a linear relationship between  $F^2$  and log t. Life time can be satisfactory well predicted by the Crine's model for given electrical stress and temperature. Acceptable lift time results can be obtained using the Crine's model for calculation. Furthermore, the life time results from the Crine's model agree with experimental results. Physical the damaged observation and chemical analysis by using FTIR supported the experimental results, as well.

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