Comparison of FT-IR & NIR method for cable classification

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1. Introduction

There are about 50,000 cables in NPP. The number of the cables need to be environmentally qualified are 1,000 cables to 3,000 cables depending on the NPP respectively. Some EQ cables are environmentally qualified and the steam test reports prepared, but some other EQ cables are not environmentally qualified or not prepared steam test reports. Not qualified EQ cables need to be qualified by steam test; high temperature and high pressure with the same condition of DBAs.

There are thousands of EQ cables in NPP but all the EQ cables don't have to be tested entirely. The steam tests can be carried out by the same types of cables. One type of cable is tested and demonstrated that the cable's capability for the duration of the installed life, all the same type of cables are qualified. Therefore, the classification the EQ cables is very important to carry out the steam test effectively. Also cable classification method selection is important, too. I tried two kinds of methods to classify the Wolsong Unit 1 EQ cables, Near InfraRed (NIR) spectroscopy and Fourier Transform InfraRed (FT-IR) spectroscopy.

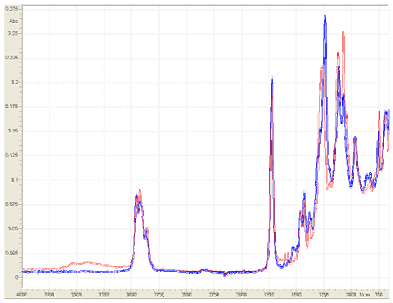
In case of old NPPs, lots of cables are missing their material information or have the wrong material information. The two methods are capable of searching for the material information of the cable. Briefly, the purpose FT-IR & NIR scanning is to find out their material information and classification of the EQ cables.

2. Method and Result

2.2 FT-IR

FT-IR spectrometer is used for both quantitative and qualitative materials analysis. The technique involves placing a sample on top of a crystal embedded in the disk with a high refractive index. An infrared beam from the spectrometer is passed up through the crystal. It is then reflected internally in the crystal, and back towards the detector, which is housed within the spectrometer. When the beam is reflected within the crystal, it penetrates into the sample by a few microns. Figure 1 shows the portable FT-IR spectrometer and Figure 2 shows the comparison of spectrum both target cable and reference cable, these two cables proved to be the same type of PVC cable.

<Figure 1 portable FT-IR spectrometer>

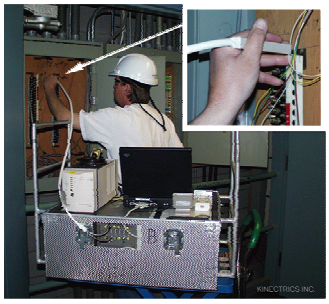


<Figure 2 the spectrum of cables>

2.1 NIR

The system of NIR is the same as that of FT-IR. FT-IR measurement needs a small specimen picked out in the site whereas the NIR measurement can be carried out in the site right on the cable. NIR technology is developed to non-destructively identify cable insulation materials in NPPs. The technique is based on the comparison of NIR spectra collected from cable insulations in the field to spectra in a library that has been constructed from various fields. These cables can be grouped into similar cable groups based on similarities in chemical composition. Cables in the field are thus identified with respect to these cable groups.

The conductor insulation of a number of cables at the Wolsong Unit 1 has been non-destructively examined using NIR method. The spectra obtained from insulation compounds of the field cables were compared with spectra generated from known formulations contained in the NIR library. In general, for a cable insulation to be positively identified, the closest matching material should have a hit quality ≤ 0.1 (more than 90% close). Figure 3 shows the NIR scanning features in the fields.



<Figure 3 NIR scanning features in NPP>

2.3 The results of the cable NIR & FT-IR scanning

To decide to NIR/FT-IR scanning points, Wolsong Unit 1 EQ cables are classified into 43 cables by the information in Wolsong site, i.e, manufacture information, cable type information, usage information(control, instrument, power). Table 1 shows the sample of target cables for NIR/FT-IR scanning.

Index	Usage	Cable Type	Manufacturer
WL-01	Control	755-5	BELDON
WL-02	Control	501-100	EATON CORP. DEKORON DIV.
WL-03	Instrument	501-14	EATON CORP. DEKORON DIV.
WL-04	Instrument	501-6	EATON CORP. DEKORON DIV.
WL-05	Instrument	501-50	EATON CORP. DEKORON DIV.
WL-06	Control	501-2	EATON CORP. DEKORON DIV.
WL-07	Control	501-4	EATON CORP. DEKORON DIV.
WL-08	Instrument	765-3	HABEG IND. CO
WL-09	Control	501-20	EATON CORP. DEKORON DIV.
WL-10	Instrument	951-2	HARBOUR INDUSTRIES
WL-11	Instrument	901-3	BECKMAN
WL-12	Instrument	No Info	GE CANADA

<Table 1 the sample of cable informations>

All the 43 cables were planned to be scanned by NIR & FT-IR at first, but some cables were not appropriate to scan because of site conditions. The reason is that some high voltage power cables were in operation and some cables were entirely sealed by the jacket, in these case, the equipments cannot be reached to cable insulation. Finally, the 38 cables of 43 cables were scanned by FT-IR & NIR and the cable classification results were found out.

Most of the cables showed the same result of cable classification in NIR & FT-IR scanning, on the other hand, 3 cables shows different results. Table 2 shows the sample of cable classification result.

Index	NIR Result	FT-IR Result	Manufacturer
WL-03	XLPE 30	E	EATON CORP. DEKORON DIV
WL-04	XLPE 30	E	EATON CORP. DEKORON DIV
WL-05	XLPE 30	E	EATON CORP. DEKORON DIV
WL-06	XLPE 30	E	EATON CORP. DEKORON DIV
WL-07	XLPE 30	E	EATON CORP. DEKORON DIV
WL-13	XLPE 30	E	EATON CORP. DEKORON DIV
WL-19	XLPE 30	E	EATON CORP. DEKORON DIV
WL-12	PVC A	J	GE CANADA
WL-14	PVC A	C	GOLDSTAR
WL-15	PVC A	C	GOLDSTAR
WL-16	PVC A	C	GOLDSTAR
WL-17	PVC A	C	GOLDSTAR
WL-18	PVC A	C	GOLDSTAR

<Table 2 the sample of cable classification result>

As shown in the table 3, WL-03, 04, 05, 06, 07, 13 and 19 showed the same results in FT-IR and NIR scanning, then classified the same type of cable and the material proved to be XLPE. WL-14, 15, 16, 17, 18 also showed the same results and classified the same type of cable. In case of WL-12, in the NIR result, WL-12 cable from GE CANADA and WL-15 cable from GOLDSTAR were classified by the same type, but the FT-IR result showed they are different.

3. Conclusion

In Wolsong Unit 1, 38 EQ cables were classified and identified their original material as a result of the FT-IR and NIR scanning.

NIR scanning showed good match with NIR database, but a few cables showed mismatch with NIR database. FT-IR scanning was carried out in the laboratory with a small piece of field cable picked out and the cable classification completed by the results NIR & FT-IR scanning.

Most of the cables showed the same result of cable classification in NIR & FT-IR scanning, but a few cables shows different results. The difference must be caused that NIR scanning was carried out in the field, there were various disturbances like dirts or dusts on the scanning cables.

We found there are some mismatch between the result of NIR scanning and FT-IR scanning due to some disturbances of NIR laser scanning in the field. It is confirmed that FT-IR scanning has to follow the NIR scanning to confirm the result of NIR scanning.

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