Initial Experience with Acoustic Imaging of PD on High Voltage Equipment

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Introduction

- Conventional electrical off-line and on-line partial discharge (PD) tests do not locate where the PD sites are
- In addition, it is often useful to confirm a high PD reading from a conventional test using a completely independent method
- Thus methods to locate and confirm PD are useful

PD Location Methods

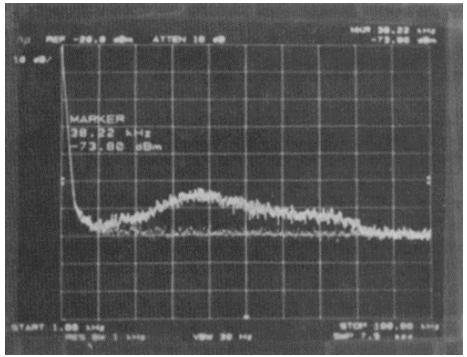
IEC 60270 and IEEE 1434 suggest RF, chemical, optical and acoustic methods:

- Locate internal and surface PD with RF probes (corona probe, TVA probe, EMI sniffer)
- In air-cooled, enclosed equipment such as switchgear and machines can detect ozone gas (electronic gas detection instruments)
- Locate surface PD using the “blackout” (also called “lights out”) test; visible light image intensifiers (night vision cameras); or ultraviolet imaging cameras
- Locate surface PD using human ears, directional ultrasonic microphones and now acoustic cameras
- This presentation concentrates on the latter

Acoustic PD Detection

- Human ears – but not very good unless one is too close to the HV test object
- In the 1950s used microphones in the audible range with a parabolic reflector to locate PD in substations
- In the 1970s directional ultrasonic microphones were commercialized. Investigation showed that there was improved PD signal to noise ratio in the 30-50 kHz range

From UE Systems Website



PD (bold) vs background noise (faint) from 1 kHz to 100 kHz

Acoustic Imaging Cameras

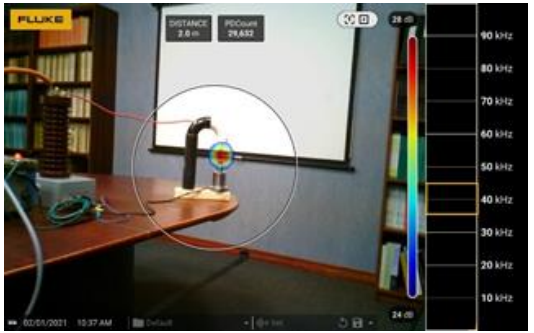
- In past few years new technology separately developed by 2 different companies used an array of microphones plus software to locate PD and place PD sites on a conventional visible light image of the test object
- Reasonably portable (2 kg mass)
- Digital downloads of images and video (to USB or Cloud)
- Evaluated the Fluke ii910 since it detects up to 100 kHz with easily adjustable lower and upper cutoff frequencies.
- Device gives display of acoustic intensity and pulse counts
- Can also place acoustic intensity on PRPD plot (but it is not synchronized to the 50/60 Hz cycle)
- Main use is for gas leak location

Acoustic Camera Evaluations

- Image vs frequency range vs distance from test object
- Acoustic vs conventional 60270 detection
- Acoustic vs UV imaging (using OFIL Daycor Superb)
- Used point-plane, stator coil and stator winding test objects

Effect of Distance from Test Object

- Used point plane test object (as in IEEE 1799)
- Color of PD site shows sound level in dB
- Sound level decreased with distance
- Background noise levels obscure PD <20 kHz and >70 kHz



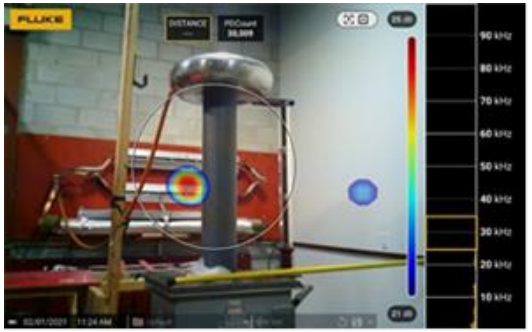
2 m

8 m

Reflection from floor

UV vs Ultrasonic imaging comparison

- 13.8 kV coil with severe semicon deterioration
- Tested at 8 kV at the same time
- Both showed about the same PDIV and PDEV
- Advantage of UV is that one can zoom on test object



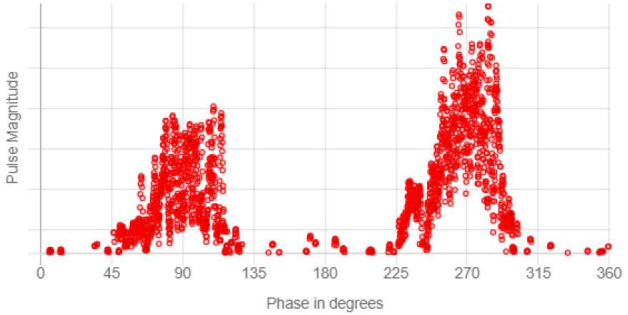
acoustic

UV

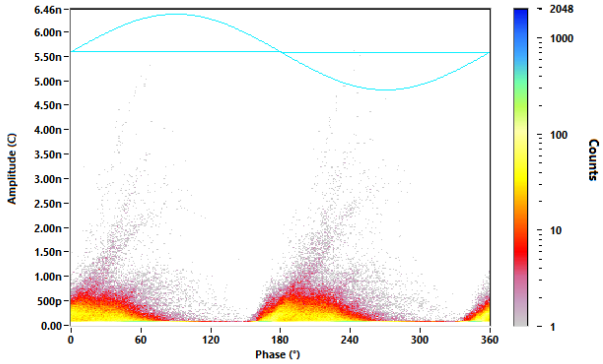
Acoustic vs Conventional (IEC 60270) PD

- Performed on stator, coil and point plane test objects
- In all cases PDIV, PDEV within about 100 V of each other using either UV, conventional or acoustic detection

acoustic PRPD

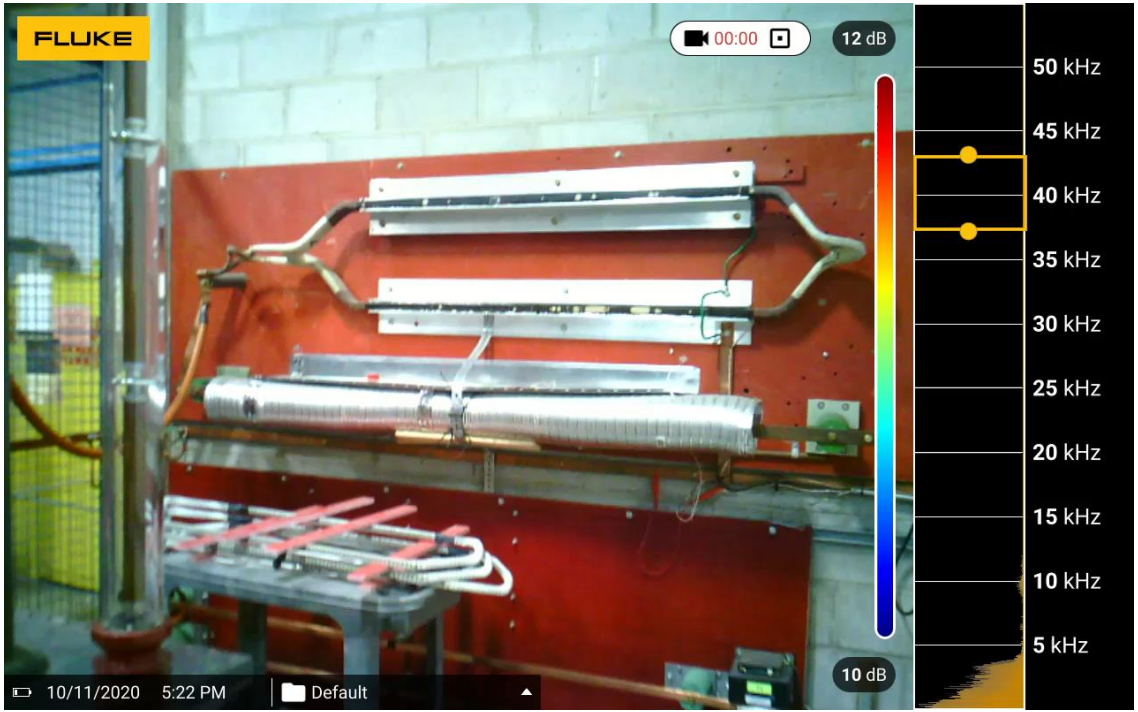


Conventional PRPD



Video of PDIV/PDEV Test on a Coil with Surface PD

- More videos at https://irispower.com/learning-centre/acoustic-camera-video-files/



Conclusions

- Acoustic imaging cameras are an interesting new technology to detect surface PD
- With a variety of test objects confirmed that 30-50 kHz range produces the best sensitivity to PD compared to background noise
- At least with one acoustic camera model, sensitivity to surface PD was almost the same as using conventional PD detection and UV cameras