

Contents

Streszczenie	7
Summary	9
List of selected symbols and abbreviations	11
1. Introduction	15
2. Diagnostics in electric power	20
2.1. Exploitation of electric power equipment	20
2.2. Aim of diagnostics of electric insulation systems	21
2.3. Factors determining the exploitation life of power equipment	22
2.4. Management strategies of electric power equipment exploitation	24
2.5. Condition assessment strategies in electric power	26
3. Signal and image based diagnostics	30
3.1. Detection of signals accompanied by degradation processes applied in diagnostic methods	30
3.2. Types of signals in electric power diagnostics	33
3.3. Mechanism of partial discharges	34
3.4. Partial discharge signals	38
3.5. Partial discharge phase-resolved images	41
3.6. Dielectric loss imaging	45
3.7. Infrared image-based trend assessment in diagnostics of electric power equipment	53
4. Partial discharge detection methods	61
4.1. Requirements for partial discharge detection and measurement methods	61
4.2. Phase resolved partial discharge acquisition	64
4.3. Waveforms of partial discharge signals	69
4.4. Phase-resolved rise time method	72

5. Assessment of HV insulating systems based on partial discharge images	79
5.1. Partial discharges in high voltage insulation systems	79
5.2. Localization and identification of corona forms based on phased resolved images	97
5.3. Assessment of electric power equipment after manufacturing processes	104
5.4. Assessment of degradation processes of fiber optic cables in high voltage transmission lines	112
5.5. Combined PD and surge test assessment of motor windings	119
6. Influence of harmonics and testing voltage frequency on phase-resolved images	128
6.1. Simulation of partial discharges at distorted voltage	128
6.2. Frequency analysis of the distorted voltage	136
6.3. Images of partial discharges at voltage distorted by higher harmonics	138
6.4. Influence of harmonics on partial discharges in aging processes	148
6.5. Influence of testing voltage frequency on PD images	150
7. Partial discharge image processing	154
7.1. Partial discharge pattern recognition	154
7.2. Application of wavelets to PD signals	159
7.3. Wavelet-based PD image de-noising	165
7.4. Neural network based recognition of partial discharge forms	177
8. Diagnostics based on high frequency analysis	187
8.1. Introduction to high frequency analysis	187
8.2. High frequency analysis of transformers	188
8.3. Transfer function based fault discrimination criteria	201
8.4. Diagnostics of electrical machine windings	213
8.5. Frequency response based diagnostics of manufacturing process	223
9. Summary	229
References	232
List of selected literature acronyms	264
Index	265