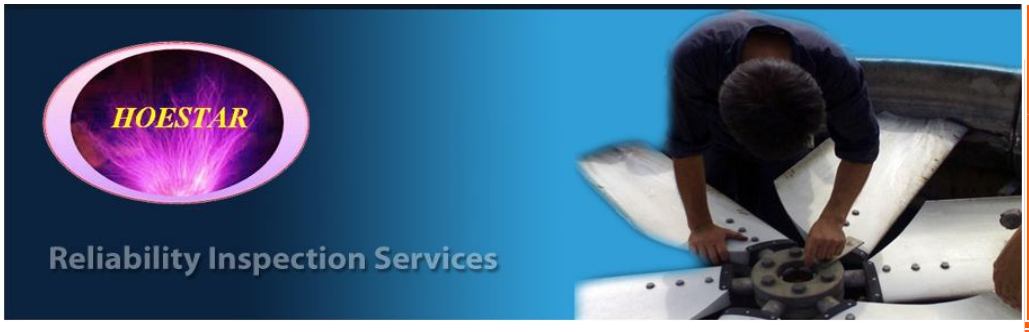
March 2014 Newsletter



Harmonics Effects on Partial Discharge (PD) Testing

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What are Harmonics?

Harmonics are electric voltages and currents that appear on the electric power system as a result of non-linear electric loads.

In a normal alternating current power system, the voltage varies sinusoid ally at a specific frequency, usually 50Hz. When a linear electrical load is connected to the system, it draws a sinusoidal current at the same frequency as the voltage.

When a non-linear load is connected to the system, it draws a current that is not necessarily sinusoidal. Examples of non-linear loads include common office equipment such as computers, Fluorescent lighting and also variable speed drives which are getting popular nowadays for energy conservation.

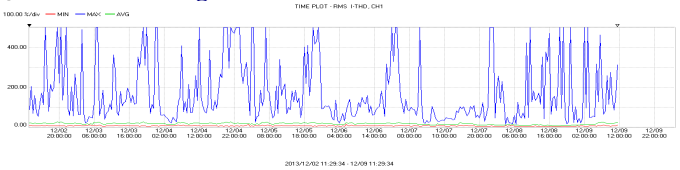
One of the major effects of harmonics is an increase in current in the system. In addition to the increased line current, different electrical equipment can suffer its effects (Overheating, Insulation Degradation) in the power system. Therefore, harmonics should be reduced as much as possible. Unfortunately, unknown to most engineers ,its effects on Partial Discharge (PD) testing is still not widely known. This is the recommended testing method for detection of insulation degradation in high voltage equipment.

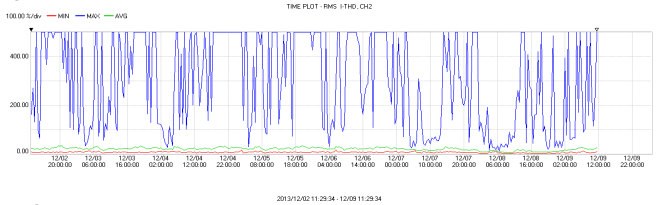
In this newsletter, we hope to share with our clients the importance of online monitoring in capturing this phenomenon which can cause serious damage to their equipment if left undetected even after a Partial discharge snapshot test which is inadequate.

This was a case study we did last year which help us to understand the importance of online monitoring without which the consequences would be disastrous.

Power Quality Monitoring (PQM)

A 7-Day of Power Quality Monitoring (PQM) are carried out on 3 phases (Red, Yellow, Blue) of an Incomer Supply of a commercial large building. The below 3 graphs shows the variation and trend of Current Total Harmonics Distortion (I-THD) for 3 phases (Ch1 -Red phase, Ch2 Yellow Phase and Ch3 –Blue Phase). In these graphs, it reveals that I-THD peaks at certain periods of time with the switching on and off in some non-linear loads.





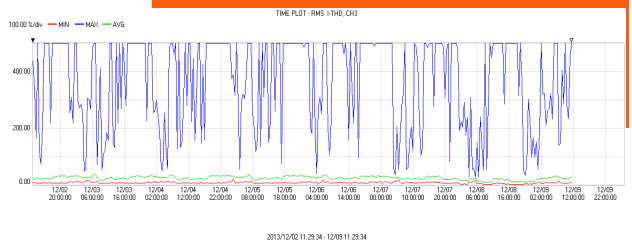


Table 1 shows the current and voltage THD% for different orders of harmonics. L2 (Yellow phase) and L3 (Blue phase) have the highest current THD of 60.61% and 68.38 %.

MSB-T2A / Q2 INCOMER SUPPLY from TF-T2-L2						
Order	Voltage %			Current %		
	L1	L2	L3	L1	L2	L3
1	100	100	100	100	100	100
2	0.18	0.06	0.05	0.63	2.34	3.62
3	0.2	0.25	0.12	4.11	22.66	11.08
4	0.29	0.04	0.03	1.94	0.24	2.41
5	1.46	1.71	1.76	47.7	48	58
6	0.29	0.04	0.06	1.44	0.6	1.64
7	0.85	0.56	0.84	24.46	26.16	31.36
8	0.22	0.01	0.03	1	0.85	0.36
9	0.18	0.23	0.14	4.28	4.29	2.77
10	0.15	0.02	0.01	0.83	0.31	0.68
11	0.33	0.25	0.22	4.6	3.68	5.02
12	0.07	0.01	0.01	0.42	0.14	0.3
13	0.08	0.01	0.01	6.67	7.21	9.34
14	0.03	0	0.01	0.28	0.14	0.23
15	0.01	0.08	0.02	1.1	2.73	0.84
16	0	0.01	0.01	0.16	0.08	0.25
17	0.14	0.12	0.11	4.28	5	4.34
18	0.01	0.01	0	0.13	0.08	0.11
19	0.08	0.04	0.07	3.31	2.35	3.64
20	0.01	0	0.01	0.12	0.06	0.18
21	0.03	0.06	0.01	0.76	1.75	0.28
22	0	0	0.01	0.11	0.13	0.2
23	0.1	0.09	0.07	3.74	4.19	3.27
24	0	0.01	0	0.09	0.08	0.05
25	0.12	0.07	0.1	2.03	1.09	2.3
26	0	0	0.01	0.08	0.05	0.16
27	0.04	0.06	0.02	0.81	1.34	0.53
28	0.01	0	0	0.06	0.09	0.06
29	0.1	0.11	0.06	2.16	2.74	1.89
30	0	0.01	0	0.04	0.06	0.04
31	0.08	0.04	0.08	1.43	1.07	1.88
32	0.01	0	0.01	0.1	0.06	0.05
33	0.03	0.06	0.02	0.4	1	0.53
34	0	0.01	0	0.05	0.08	0.11
35	0.1	0.1	0.06	1.76	2.08	1.43
36	0	0	0	0.04	0.06	0.03
37	0.06	0.03	0.05	0.9	0.49	1.02
38	0	0.01	0	0.06	0.06	0.03
39	0.03	0.06	0.02	0.22	0.77	0.46
40	0	0.01	0.01	0.07	0.1	0.09
41	0.09	0.11	0.07	1.32	1.71	1.25
42	0.01	0.01	0	0.03	0.08	0.09
43	0.06	0.05	0.05	0.77	0.52	0.79
44	0.01	0	0	0.04	0.06	0.07
45	0.01	0.05	0.03	0.16	0.58	0.43
46	0	0	0.01	0.05	0.06	0.1
47	0.08	0.1	0.06	0.95	1.06	0.85
48	0	0.01	0.01	0.04	0.05	0.05
49	0.05	0.03	0.04	0.57	0.37	0.68
50	0.01	0	0	0.03	0.05	0.06
THD %	1.85	1.88	1.99	55.2	60.61	68.38

Table 1: Voltage and Current THD (%) for different orders

Table 2 shows the Power Quality parameters (Voltage, Current, Power, THD-U % and THD-I % etc). These inconsistencies of current harmonic distortion were suspected to be due to loading.

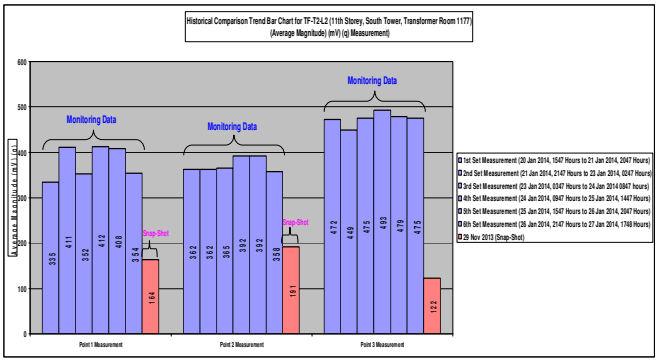
Summary Table 2.5 MSB-T2A / Q2 Incomer Supply from TF-T2-L2

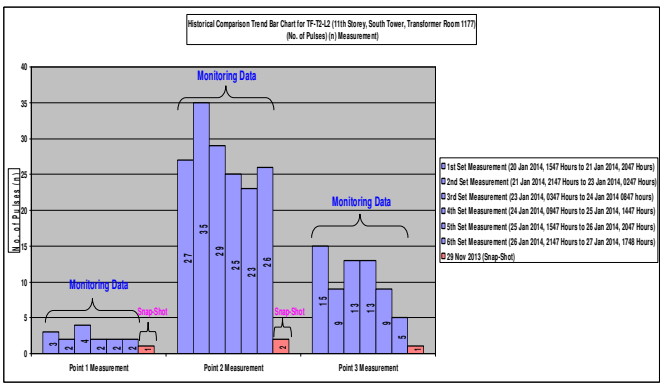
2nd December 2013 to 9th December 2013 (J3)					
		L1	L2	L3	Neutral / (Sum)
Voltage(V)	Max	245.94	246.17	247.38	1.06
	Min	234.72	235.01	236.49	0
Current(A)	Max	1035.9	1074	1065.12	136.15
	Min	15.2	14.2	9.6	26.77
Power (kW)	Max	246.8	257.40	255.2	(758.9)
	Min	-45.4	-56	-53.1	(-145.6)
Power (kVA)	Max	248.4	258.3	257.2	(763.3)
	Min	3.7	3.4	2.3	(15.5)
Power (kVAr)	Max	133.8	130.7	140.3	(404.8)
	Min	-14.6	-21.4	-20	(-49.4)
PF	Max	0.99	0.99	0.99	(0.99)
	Min	-0.99	-0.99	-0.99	(-0.99)
THD-U %	Max	2.84	2.82	2.93	-
	Min	0.57	0.53	0.55	-
THD-I %	Max	487.92	493.83	498.33	-
	Min	2.62	2.77	2.92	-
Frequency(Hz)	Max	50.248			
	Min	49.66			

Table 2: Power Quality Measurement Parameters

Partial Discharge Online Testing

As a result of the high THD detected a 7-Day Partial Discharge (PD) Online Monitoring exercise was carried out on the same 3 phases of this equipment which is a cast resin transformer of 22kV. The results of the PD Measurement readings are summarized in the PD Bar charts shown below.





Partial Discharge Measurement

The Partial Discharge (PD) measurement are carried out both in snap shot mode as well as online monitoring mode. The Online monitoring data is colored in blue while the snap shot data is colored in pink.

From the PD Bar charts, it can be observed that PD activities (Average magnitude and pulse count) has risen tremendously as compared to the values of the snapshot measurements during the 7 days of monitoring. This goes to show how the effects of harmonics and changing loads have affected the PD activities of this equipment. PD online monitoring thus provides more detailed analysis to study the effects of harmonics on partial discharge activities over a period of time. Has this not been done, we would think the PD condition is much better than it really is. With this new information, more regular inspections and maintenance is being planned to prevent any opportunity for the PD activity to increase into the undesired range although its condition is still within normal limits.

Conclusion

Therefore in the long term, it is important to maintain the equipment thoroughly with regular partial discharge monitoring carried out half yearly for the equipment in case of further rise in harmonics content or other factors such as load, temperature etc, that will lead to further increase in partial discharge activities thus causing sudden damage. There have been documented cases of equipment failing within 2-3months after a snapshot test.

SINGAPORE OFFICE

Hoestar Inspection International Pte Ltd
Address : 5A Siang Kuang Avenue, Singapore 347923
Tel : (65) 6488 1604 Fax : (65) 6281 9477
E-mail : sales_enquiry@hoestarinsp.com.sg