Foretec electric
Passion in Power Quality

ADVANTAGEOUS AND CASE STUDY ON PASSIVE FILTER IN POWER QUALITY

Foretec Electric India Pvt ltd
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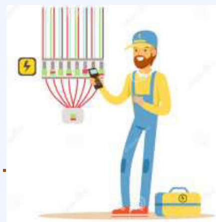
ABOUT US

- ✓ At FORETEC, we are focused forerunner company in the field of Power Quality and Energy Management, and related services over two decades offering the following solution for various type of industries and applications.
- ✓ We have always believed in serving the best and reliable Solution and Products on Power Quality possible in the Industry
- ✓ We are proficient in execution of Power Quality Products with Passive Filters to any type of application either pre-designed or design & build solutions.
- ✓ Our clients are in India and Abroad
- ✓ Our Mission is 'To constantly improve what is essential to Energy Efficiency progress by mastering Engineering and technology.



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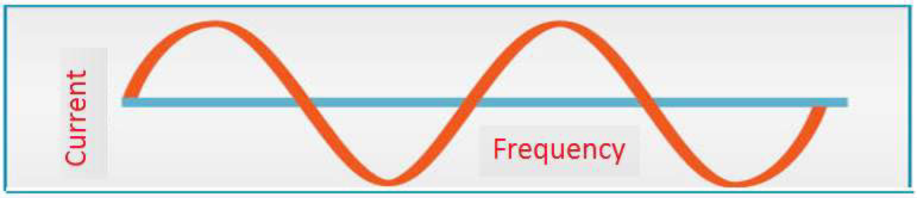
INTRODUCTION – POWER QUALITY

- Power Quality means quality of the normal voltage supplied to your facility
- The growing use of microprocessors and electronic equipment has made us to focus on power quality
- Equipment and machinery can be damaged or even fail when subjected to power anomalies
- Voltage provided should be as close as possible to nominal voltage and waveform must be pure sine wave free from any harmonics and other disturbances



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IEEE STD 519-2014

Maximum harmonic current distortion in percent of I_L						
Individual harmonic order (odd harmonics)[a, b]						
I_{SC}/I_L	$3 \leq h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h \leq 50$	TDD
< 20[c]	4.0	2.0	1.5	0.6	0.3	5.0
20 < 50	7.0	3.5	2.5	1.0	0.5	8.0
50 < 100	10.0	4.5	4.0	1.5	0.7	12.0
100 < 1000	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

[a]Even harmonics are limited to 25% of the odd harmonic limits above.

[b]Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

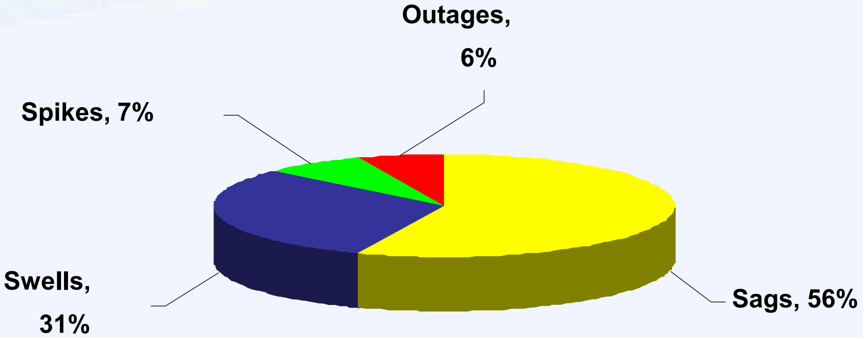
[c]All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L

where

I_{sc} = maximum short-circuit current at PCC

I_L = maximum demand load current (fundamental frequency component) at the PCC under normal load operating conditions

Major PQ Problems



Source: EPRI, 1994

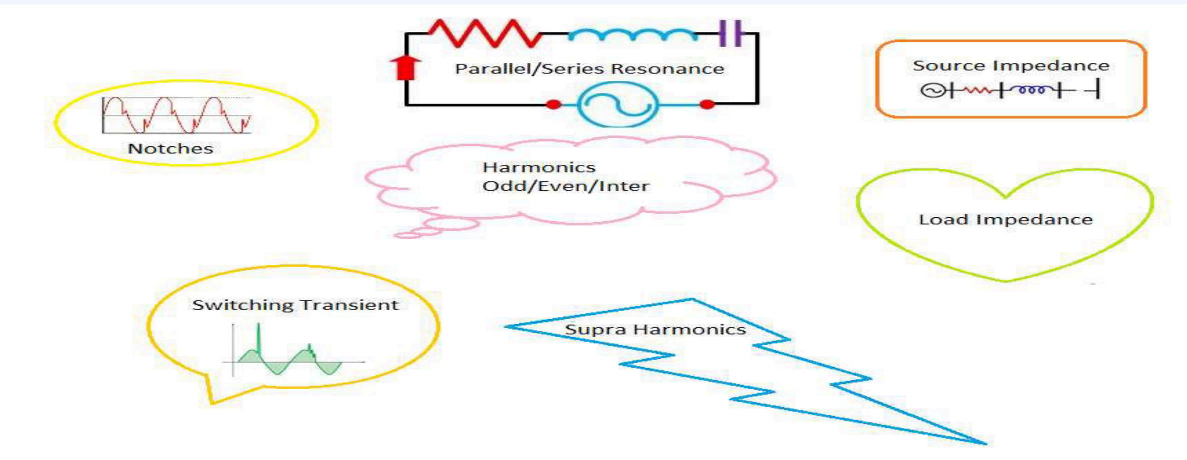
Swells
System fault conditions
Switching on a large capacitor bank
Switching off a large load

Sags (Dips)
Associated with system faults
Switching of heavy loads
Starting of large motors

CHALLENGES TO PROVIDE THE SOLUTION

To solve the issues or enhancement of Power Quality various solutions are available, which could be either plug and play or customized.

CHALLENGES ENCOUNTERED ON POWER QUALITY TO PROVIDE THE RIGHT SOLUTION



CHALLENGES ON DESIGN ENSURING THE PERFORMANCE

- No filter can perform well or work for long life in power quality unless considering the following
- Design of PHF design considers the following
  - ✓ Fault level from Source up to downstream
  - ✓ Source Impedance
  - ✓ System resonance frequency
  - ✓ Load side impedance
  - ✓ ODD, Even* and Inter Harmonics
  - ✓ Notches
  - ✓ DC offset

REQUIREMENT FOR THE SOLUTION

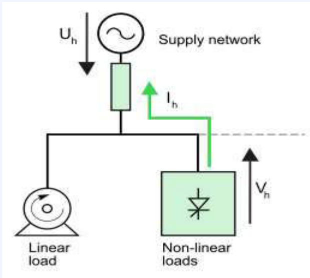
- ✓ Understanding the problem clearly
- ✓ Solution to be compatible with that particular location
- ✓ By considering the various electrical parameters
- ✓ When tailor made the solution to be futuristic by considering various other issues and anticipated load
- ✓ Adoptability to any changes on design when changes in Short Circuit level Isc/Source Impedance
- ✓ Harmless, natural way, user friendly and ofcourse reliability and outcome has to be reducing the carbon foot print by conserving the energy

WHICH IS THE RIGHT SOLUTION

Few different types of technology available in the market

HOWEVER the solution and Product to solve the issue has to be compatible to the following – Because of

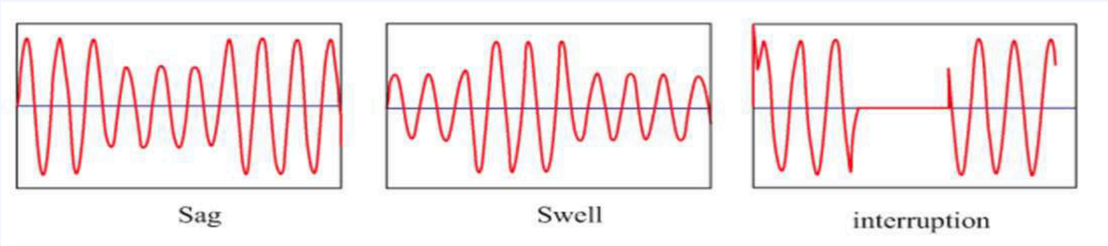
- ✓ Non Linear Load and its distortion is not only the parameter to consider
- ✓ Distortion level of any non linear load will vary depending on its installed location.
- ✓ Various grid related parameters changes in load side performance of Machines, distortion and other PQ related issues
- ✓ Linear load also Generator of Harmonics, which is too hard to handle some time.



WHICH IS THE RIGHT SOLUTION

IN TRUE SENSE PASSIVE FILTERS ARE ONLY FILTERS IN THE FIELD OF POWER QUALITY

- ❖ Passive Filters are more efficient to solve most of the above discussed issues
- ❖ Harmonics – Any type of application with highly variable load including inter harmonics
- ❖ Voltage Notches
- ❖ Considerable protection from Swell, Surges in voltage



MISCONCEPTIONS ABOUT PASSIVE FILTERS

- Tuned to specific order of harmonics – No need to shift the resonance frequency closer to rich Harmonic order. This will generate dangerous resonance some time.
- If change in load or location – Entire filter has to be abandoned. Wrong. Any suitable location for its operation can accommodate and no need to change the design or replace
- Triplent order filtering – Not possible or poor performance –

  Passive is the best performer than any other method
- Highly Variable Load – Impossible to perform – Wrong –

  Passive will perform highly Dynamic Load better than any others.

  (Ex. Induction melting furnace)

Even order*

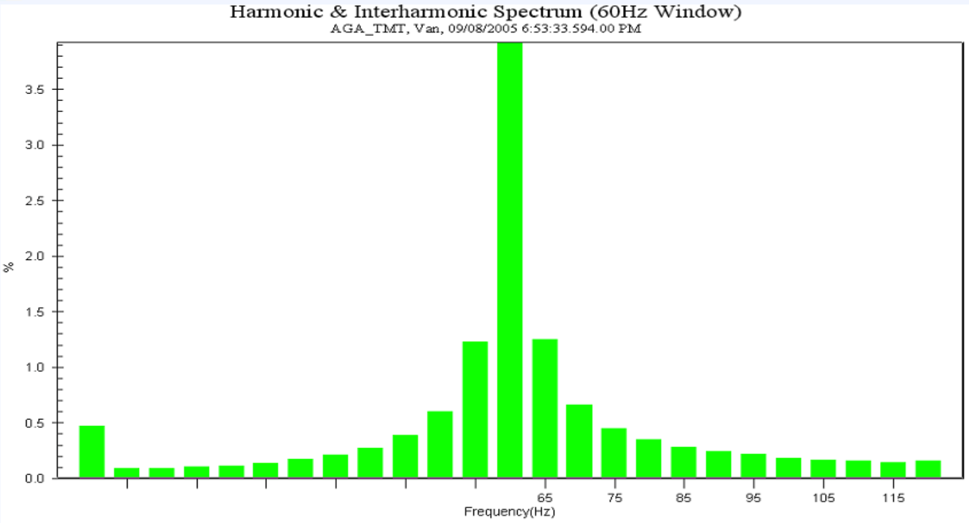
ADVANTEGOUS

- Traditional and basics in Electrical system
- No need of power for its operation
- As No high speed switching
  - ✓ No presence of 'RIPPLES
  - ✓ No Supra Harmonics (2-150kHz)
  - ✓ No Inter harmonics Generation and elimination can be done
  - ✓ No TIF (Telephone Interference Factor) and Noise
- A properly designed Wide Spectrum Passive Filter, can outperform especially when harmonics up to the 100th are taken into consideration – Ref-Dr.Tony Hoevannars – Member IEEE – Mirus International Inc/Canada

ADVANTEGOUS

- No need to depend any external signal like Current Transformers for its operation. Frequency Response of available CTs are capable of measuring less than 600hZ
- PHF clean the entire system even installed at any location
- Reduction of DC offset
- Reduction on Temperature on entire Electrical system - Transformers, Motors, Cables, Switch gears and etc
- Stand alone and no need of any other filtering support
- Improves the accuracy and reliability of all protective relays. Hence operator/user safety ensured
- Passive filters are rugged- Hence failure is limited
- Dynamic performance in highly variable Load

Harmonic & Interharmonic



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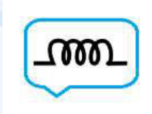
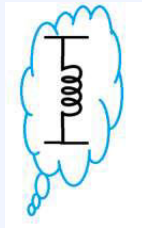
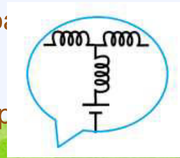
TYPE OF FILTERS



- Detuned filters -189hz , 210hz and 133 for anti resonance performance and partial shifting of TF and perfect design give the output of moderate performance in control of THD
- Low Pass - for Harmonic Limiting
- Low Pass for Inrush current Limiting
- Broad Band Low pass – For 6 pulse application – Swiping from 5th to 13th spectrum
- Broad Band High Pass – Higher order frequencies
- Shunt filters - Decompensation of over compensation, protection against Ferro resonance elimination of Harmonics, Protection from Surge/Transients and Swell
- Saturable Core Reactors for Decompensation of Reactive Power on unbalanced loa real time performance by changing its excitation DC volts
- DC Link chokes – For DC Bus links in between convertor and invertor and DC supp





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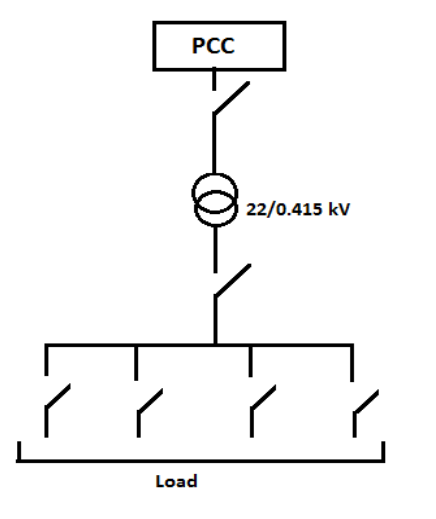
DIFFICULTIES WITH PHF and HOW TO HANDLE

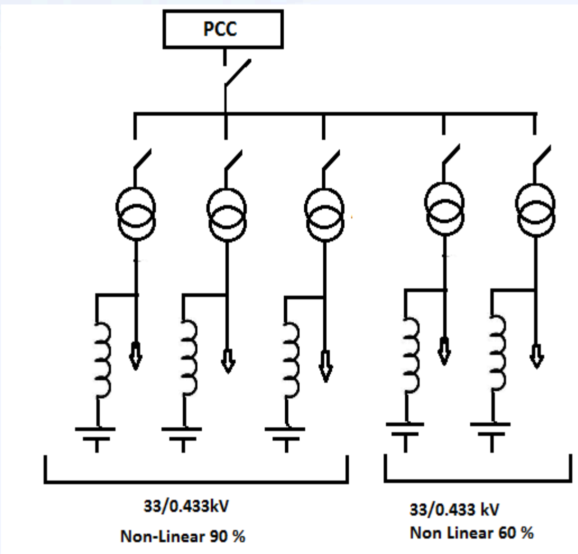
- Skill in design
- Bigger size. Hence need more space
- Emission of High Temperature – (Proper design and location of installation)
- Wherever comes in 'series' needs to rework entire cable and its terminations
- However

CASE STUDIES – TEXTILE INDUSTRY – Case Study - 1



AMMARAVATHY SPINNING INDUSTRY		
Date of Test	27.10.2014	12.08.2015
Voltage Level at PCC (kV)	22	22
Sanction Demand (KVA)	1280	1280
Individual Voltage Harmonic (Distortion Max)	1.34 %	0.67 %
Total Voltage Harmonic Distortion	1.66 %	0.69 %
Total Current Harmonic Distortion (TDD)	26.52 %	5.706 %

Case Study - 2



Foundry		
Date of Test	22.11.2014	13.02.2015
Voltage Level at PCC (kV)	33	33
Sanction Demand (KVA)	8100	8100
Individual Voltage Harmonic (Distortion Max)	1.39 %	1.07 %
Total Voltage Harmonic Distortion	2.03 %	2.07 %
Total Current Harmonic Distortion (TDD)	16.75 %	6.44 %

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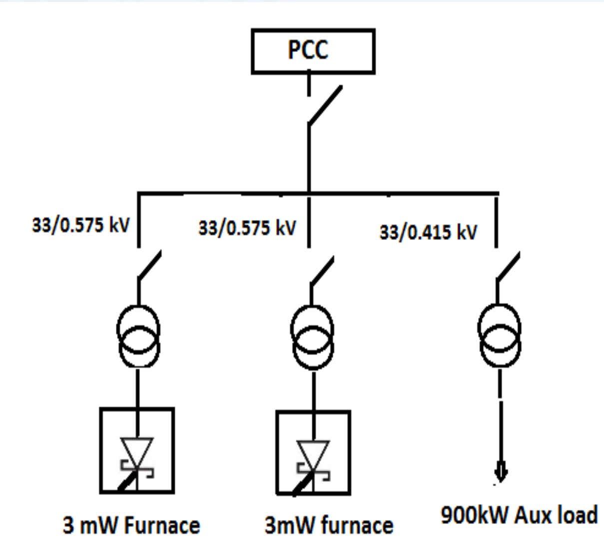
Case Study - 3



Foundry		
Date of Test	21.04.2015	23.01.2019
Voltage Level at PCC (kV)	33	33
Sanction Demand (KVA)	5050	5050
Individual Voltage Harmonic (Distortion Max)	2.81	2.09
Total Voltage Harmonic Distortion	4.02	4.03
Total Current Harmonic Distortion (TDD)	16.42	7.258

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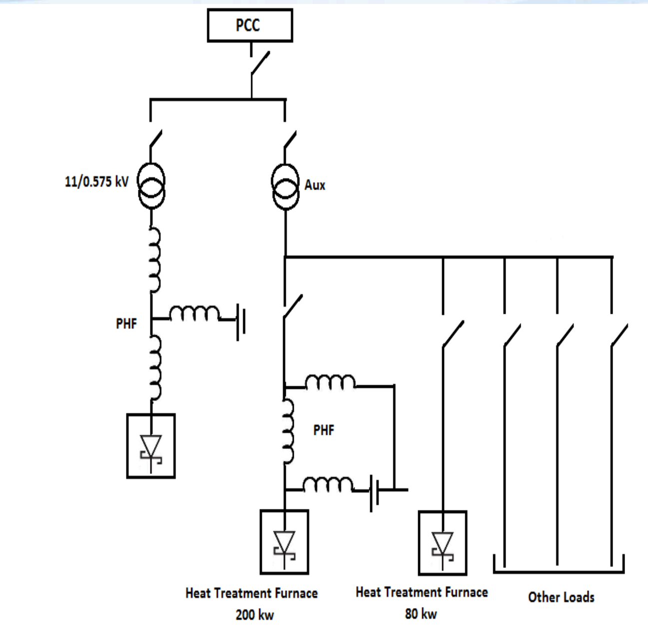
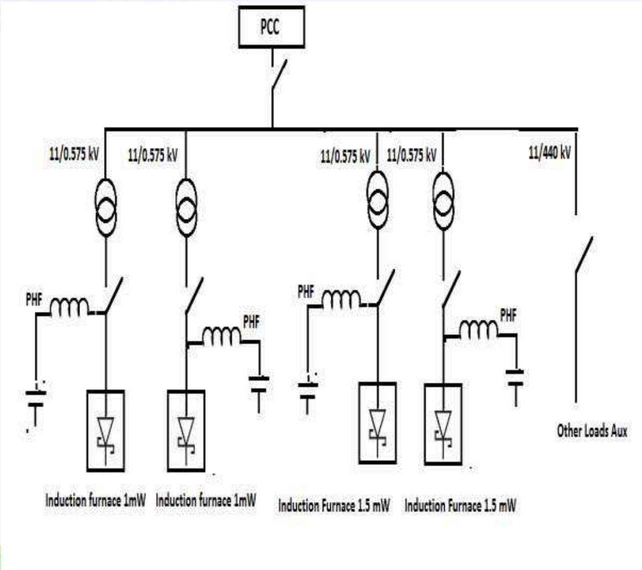
Case Study - 4



Foundry		
Date of Test	19.11.2014	30.04.2015
Voltage Level at PCC (kV)	11	11
Sanction Demand (KVA)	4310	4665
Individual Voltage Harmonic (Distortion Max)	7.66	2.35
Total Voltage Harmonic Distortion	8.22	4.14
Total Current Harmonic Distortion (TDD)	17.6	5.79

Case Study - 5



Foundry		
Date of Test	19.11.2014	14.06.2016
Voltage Level at PCC (kV)	11	11
Sanction Demand (KVA)	2373	2373
Individual Voltage Harmonic (Distortion Max)	3.45	1.34
Total Voltage Harmonic Distortion	3.54	1.51
Total Current Harmonic Distortion (TDD)	16.58	5.61

Temperature Reduction

THANK YOU