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Designing and Harmonic Analysis of Shunt Hybrid Filter with 24 Pulse Converter

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Abstract:

According to IEEE-519 standard the Total Harmonic Distortion (THD) in a power system must lie within 5%, but as the demand of power electronic devices is increasing exponentially, the harmonic generation is becoming a serious problem to the power system. For reducing harmonic, 3 phase Shunt Hybrid Filter topology is used for high voltage with 24 pulse ac/dc converter. The 24 pulse converter has been obtained from combining four six pulse rectifier in parallel, since these rectifier are connected to two 3 phase transformers, so that the desired phase shift is obtained by utilizing star and delta connections.24 pulse converter primarily focuses on harmonics reduction. Wherever it'll reduce the lower order harmonics like 5th, 7th, 11th and 13th.However this 24 pulse device is relatively a lot of economical than alternative rectifiers was concisely explained, verified and stimulated by using MATLAB & SIMULINK.

Index Terms—hybrid filter, 24-pulse converter, 3 phase transformer, fuzzy logic controller

I Introduction

Nowadays, power electronic based equipment are used in industrial and domestic purpose. These equipments have significant impacts on the quality of supplied voltage and have increased the harmonic current pollution of distribution systems. They have many negative effects on power system equipment, such as additional losses in overhead and underground cables, transformers and rotating electric machines, problem in the operation of the protection systems, over voltage and shunt capacitor. Due to harmonic current error of measuring instruments, and malfunction of low efficiency is coming in the loads. Harmonics pollution and reactive power compensation are become more serious issues of power quality.Solutions involve several techniques that include the use of passive and active power filter (APF). A more advance approach is the use of hybrid filters with 24 pulse converter. In hybrid filter using both the passive filter and shunt APF in combination. They are being used to eliminate both the lower order and higher order harmonics. The passive filter is normally designed to eliminate the bulk of load-current harmonic leaving the more complex problems to be solved by the APF.

The Conventional rectifiers are created using diodes and thyristors, which is controlled and uncontrolled has the following issue such as reduction in power quality due to current harmonic injection , low efficiency and in need of large size of AC and DC filters.

To reduce the disadvantages of these converters and to obtain the enhanced power quality, the examination has been done to find out the solution to this disadvantages and it has ended with multi pulse diode converters for the conversion of AC/DC. Multi-pulse rectifiers are unidirectional and were

utilized for high power applications. But considering the economic condition the 24 pulse converter selected for its advantage.

II Harmonic

Harmonics provides a mathematical analysis of distortions to a current or voltage waveform. These are integral multiples of the central power frequency. Harmonics are steady state distortions to current and voltage waves and repeat every cycle. These are integral multiples of the power frequency.

Harmonic voltages and currents in an electric power system are a result of non–linear electric loads. Harmonics frequencies in the power grid are a frequent cause of power quality problems.

Harmonics in power system result in increased heating in the equipment and conductor, misfiring in variable speed drives and torque pulsations in motors. Reduction of harmonics is considered desirable. The term 'Harmonic' refers to a component with a frequency that is an integral multiple of the fundamental frequency. Harmonics in power system arises due to wide use of nonlinear loads. The major causes of current and voltage harmonics are due to energy conversion techniques and control involved in the power electronic devices such as rectifier, chopper, cyclo-converter etc. Energy conversion devices like voltage controller devices of motor, HVDC power converter, battery-charging systems, power factor improvement devices, traction, static-var compensators, direct energy devices-fuel cells, wind and solar-powered dc/ac converters, storage batteries which require dc/ac power converters, control of heating elements cause harmonic pollution in power system ..

Causes of Harmonics:

- It can be caused by any electrical equipment that uses switched mode power supply.
- Due to improper switching of the converter switches, on linear loads, faults, etc.

Results of Harmonics

- Harmonic current can cause overheating of the distribution system.
- It will cause voltage distortion reducing the amount of voltage to the load circuit.
- It will add to the loss component of the system.
- Interference in telephone lines.

III Design Of Fuzzy Logic Pi Controller

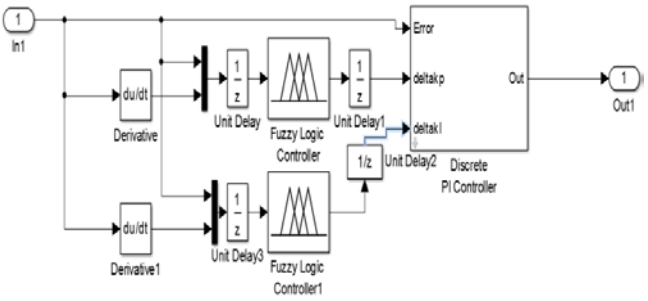

Fig.1 Simulink diagram of Fuzzy Controller

The FLC concept was proposed in 1965 that was based on a logical system called fuzzy logic. It is much closer in spirit to human thinking and natural language. FLC was deduced from fuzzy set theory. Fuzzy sets boundaries were undefined, ambiguous and useful for approximate systems design. FLC is used for the SAPF in closed loop to control a constant DC voltage, improve the SAPF performance and reduce the *THD* of the current. The (*e*) and its derivation (*de*) are used as inputs for fuzzy process as in figure . FLC output (*C de*) is *I*max. The FLC characterized by:

(1) five fuzzy sets in linguistic variables are Negative Large (NL), Negative Small (NS), Zero (ZE), Positive Small (PS) and Positive Large (PL) for each input and output variables.

(2) Triangular membership function is used

(3) Implication using mamdanitype min-operator, and

(4) Defuzzification using the centriod method.

Fig.1 shows Operation of FLC. A fuzzy logic controller is consisting of four stages: fuzzification, knowledge base, inference mechanism and defuzzification. The knowledge base is composed of a data base and rule base and is designed to obtain good dynamic response under uncertainty in process parameters and external disturbances .The data base consisting of input and output membership functions, provides information for the

appropriate fuzzificztion operations, the inference mechanism and defuzzification. The inference mechanism uses a collection of linguistic rules to convert the input conditions into a fuzzified output. Finally, defuzzification is used to convert he fuzzy outputs into control signals. In designing of a fuzzy control system, the formulation of its rule set plays a key role in improvement of the system performance.

PI-controller

This controller estimates the output as *Imax* and controls the DC voltage. The error (*e*) passes through it, this controller is eliminating steady state error in the DC voltage. Its transfer function *H(s)* is defined.

$$H(s) = K_P + K_1/s$$

$$Output\ (I_{max}) = e^* K_P + K_1 \int e\ dt$$

Where, *KP* is the proportional constant that determines the dynamic response of the voltage control and *KI* is the integration constant that determines the settling time.

IV Hybrid Filters

Hybrid filters are based on the combination of active filters and passive filters. Such a combination with the passive filter makes it possible to significantly reduce the rating of the active filter. The task of the active filter is not to compensate for harmonic currents produced by the thyristor rectifier, but to achieve harmonic isolation between the supply and the load As a result, no harmonic resonance occurs, and no harmonic current flows in the supply.

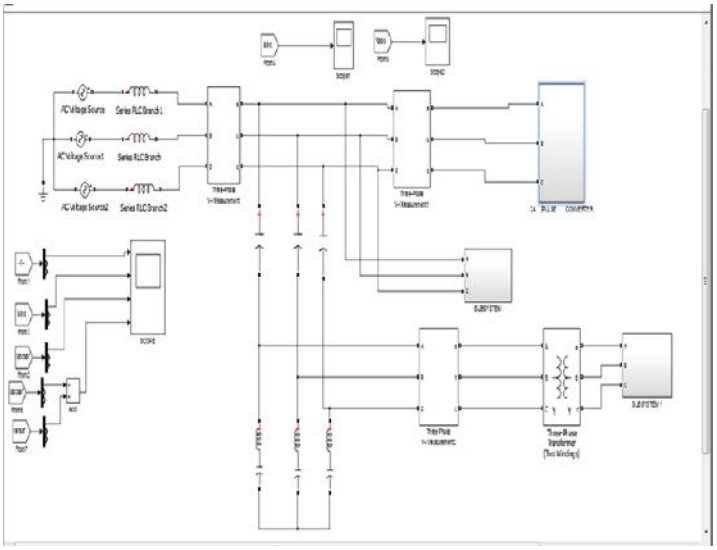

Fig 2 simulation of hybrid filter

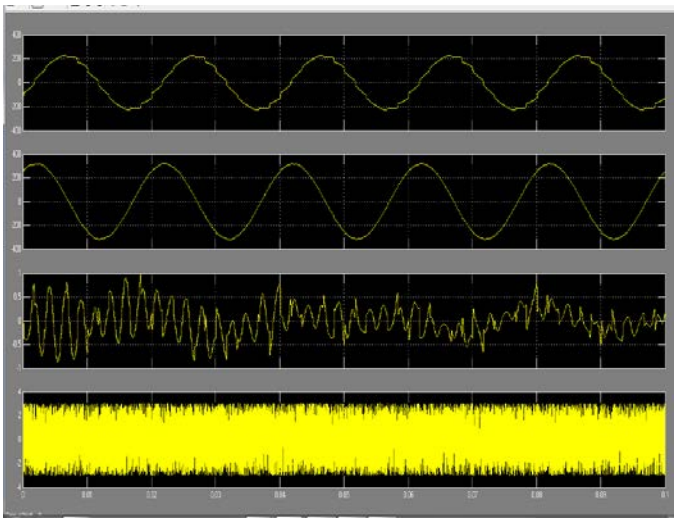

Fig.3 Waveform

V Multi-Pulse Methods

The number pulses in the dc output voltage within one time period of the ac source voltage is called pulse number. For high power applications, AC-DC converter which based on the concept of multi-pulse namely 6, 12, 18, 24, 30, 36, 48 pulses. These pulses are connected to the 3 winding of 3 phase transformer with pulse converter.

The multi-pulse technique can be executed in the following versions:

parallel or series connection of basics systems (for instance, three-phase bridge systems) with relevant phase shift of supply voltages.

use of multi-pulse autotransformers.

parallel connection of basic systems with the use of coupled reactors .

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VI 24-PULSE CONVERTER

A simplified type of twenty four pulse rectifiers has been proposed for dc applications, the twenty four pulse converter has been obtained from combining four six pulse rectifier in parallel, since these rectifier are connected to two 3 phase transformers, so that the desired phase shift is obtained by utilizing star and delta connections. So every individual six pulse rectifier output is supplementary to induce the relevant voltages. The look of twenty four pulse converter primarily focuses on harmonics reduction, commonly diode rectifiers is wide used for AC/DC conversion. a serious disadvantage is, the rectifiers can inject giant harmonic distortion within the input currents. Clearly a 12-pulse device is employed for reducing the harmonics injected; however it additionally includes the (12n±1) harmonics within the input currents. So as to scale back the harmonics within the input current, the twenty four pulse rectifier is projected. Wherever it'll reduce the lower order harmonics like 5th, 7th, 11th and 13th. though Its reduces the low order harmonics , however the AC output voltage from transformer would have 24n±1 order harmonics due to the phase shift concerned in transformer. However this 24 pulse device is relatively a lot of economical than alternative rectifiers was concisely explained, verified and stimulated by using MATLAB & SIMULINK package.

24 pulse converter operation, working of phase shifting transformers formed by delta to star and delta to delta conversion . And also the harmonics comparison of 24 pulse converter over the low pulse converter. A 12-pulse rectifier is formed by combing two 6-pulse rectifiers fed from two 3-phase systems dislodged by 30º. The 24-pulse rectifier topology is gotten by combining two 12-pulse rectifier systems which mean combining of four 6-pulse rectifiers fed from four 3-phase systems relocated by both 30 º and 60º.

VII Matlab Based Simulation Results Of 24 Pulse Converter

24–pulse AC-DC converters are reproduced and stimulated in a MATLAB environment alongside Simulink and Power System Blockset (PSB) toolboxes. The AC- DC converter supplies the consistent RL Load (R= 50 ohm , L=0.65 H) with an input of 300v, 50Hz AC supply. The MATLAB model of a 24-pulse AC- DC converter is demonstrated in Fig.3 presents a MATLAB model of the 24-pulse AC- DC converter. Resultant waveforms of the 24-pulse AC- DC converter are indicated in Fig.4. (vo1, vo2, vo4, vo5).The required output of the rectifier is demonstrated in figure Fig.4 (vo3).

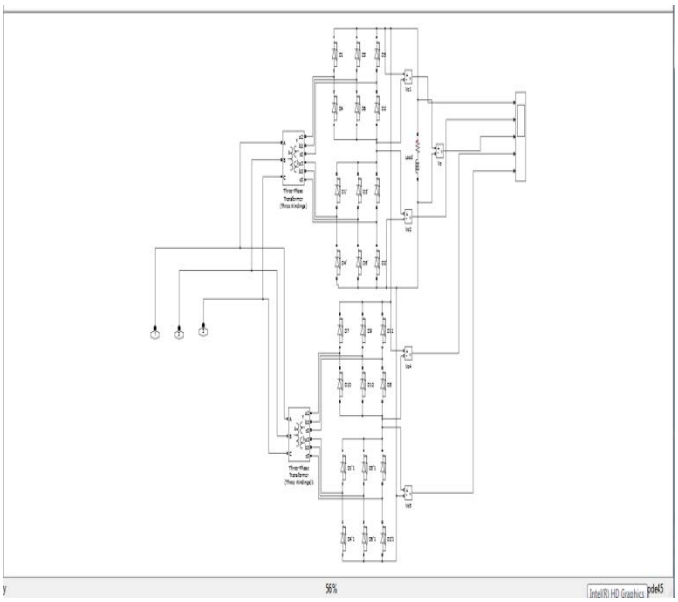

Fig.4 24-pulse converter

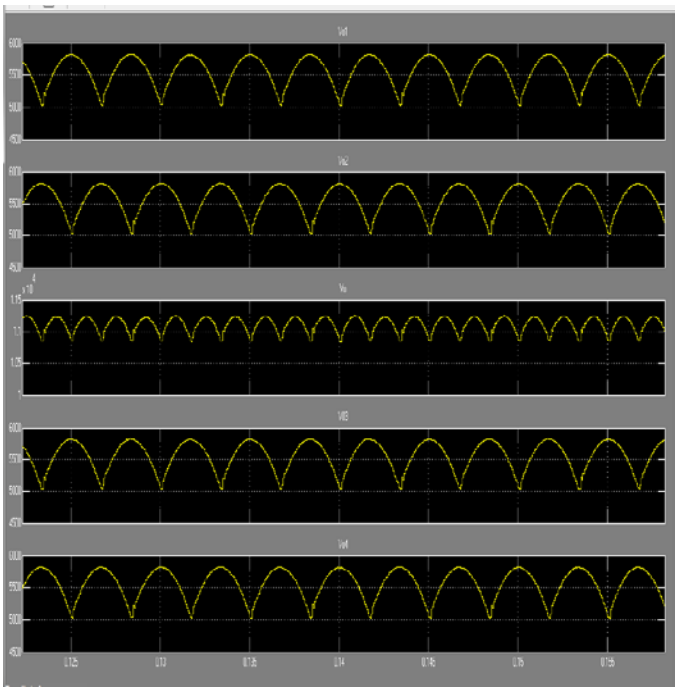

Fig.5 24 pulse waveform

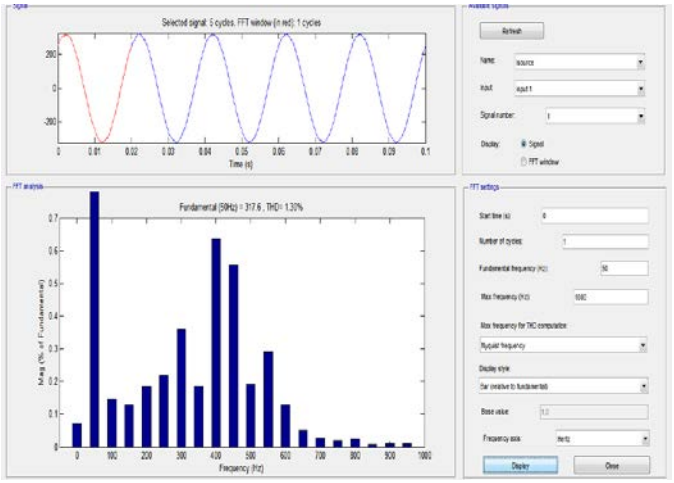

Fig 6 THD (1.30%) % for input current

VIII CONCLUSION

The voltage and current waveforms were distorted because of the presence of harmonics. A filtering technique combining Passive power and Shunt Active Power Filter is proposed in this research. With the proposed control algorithm, the hybrid filter improves the harmonic compensation features of the passive filter and the power factor of the load. The problem of distortion in 24 -pulse converter is reduced to a great extent using Hybrid Power Filter. The model was validated using MATLAB/ Simulink. In this project ,the proposed outline, reproduction, and test outcomes, it has been watched that power quality has been enhanced altogether by utilizing the proposed phase shifting transformer based 24-pulse AC-DC converter .since the harmonic distortion is reduced in the proposed 24 pulse converter. And this outlines that the proposed plan is suitable for minimal effort, high voltage applications. The ensuing 24-pulse converter has displayed a high level of execution with clean power qualities. Overall, this compensation technique not only reduces the harmonics but also ensures the improvement of the system performance.

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BIBILOGRAPHY

Anumeha kumari received B.Tech degree in electrical and electronics engineering from SHIATS in 2015, and perusing M.Tech in power system from SHUATS.