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ANFIS Based STATCOM for Compensation of Reactive Power and Harmonics with Cascaded H-Bridge Multilevelinverter

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ABSTRACT: This paper investigates the improvement of voltage stability using STATCOM based on CHB Multilevel Inverter. In a transmission line if there is a sudden load change occurs it lead to power quality issues . STATCOM is connected in parallel with the transmission line and eliminates the voltage distortion. Normal inverter produces the non-sinusoidal waveform so the power quality may get reduces so the multilevel inverter is implemented in STATCOM to overcome this issue. Additionally, DC link voltage stability is improved using the ANFIS controller.

KEYWORDS: FACTS, STATCOM, Adaptive fuzzy Inference system **(ANFIS),** cascaded H bridge multilevel inverter **(CHB),** power quality **(PQ)** Total harmonic distortion **(THD**)

I. INTRODUCTION

Power distribution system should provide an un-interrupted supply to their consumers with smooth sinusoidal voltage and constant frequency Distribution systems consist of several non- linear loads that considerably affect the quality of power. power quality can also affected by the events like capacitor switching ,motor starting

PQ problem is defined as any established problem in voltage, current or leading to frequency deviations. It will result in failure or mal–operation of the customer equipment

Mostly occurring PQ problems are voltage sag and swells. Voltage sag affects the industrial processes more severly.The effects of low power quality at the industry side led to 1.Low productivity 2.Often failure of the equipment.3.Equipment over heating 4.Increased reactive power demand 5.mal functioning of the equipment 6.Increase production cost and decrease product quality The power quality problems can be mitigated or avoided by using facts controlled devices . Power quality compensators are mainly divided into two types 1.Shunt compensation device which eliminate the harmonics effectively.2.series compensation device which correcting the distorted system voltages and voltage sags.

In transmission line STATCOM can exchange both active and reactive power .These are achieved by the way of varying the amplitude and phase angle of the converter voltage in response to the line terminal voltage. The Normal inverter has the following disadvantages 1.Non-sinusoidal output voltage 2.Need of complex filter design and3.It produces more harmonic content. So the multilevel inverter is introduced in STATCOM application. In multilevel inverter output harmonics can be decreased by increasing the number of output voltage level. There are several types of multilevel inverter, among them cascaded H bridge multilevel inverter is selected for the STATCOM application due to the reduced number of switches and switching losses, and improved harmonic performance . CHB inverters can also increase the number of output voltage levels easily by increasing the number of H-bridges.

STATCOM with a PI controller based CHB multilevel inverter reduces the harmonics and compensate the reactive power.(1) .A control algorithm for supplying reactive power to the grid and the compensation of reactive power with help of transformer-less CHB STATCOM is presented in (2). From this concept the converter stability is improved. The cancellation of harmonics within each leg is implemented in (3). Using this technology depending upon the switching frequency, harmonic performance are improved.

The method of novel control for a transformer-less cascaded STATCOM with star configuration provide not only to the current loop control but also to the dc capacitor voltage control.(4) In an analytic voltages filtering scheme , a high reliability film capacitor is used instead of electrolytic capacitor in (5) DC-link capacitors plays major role in most of the of power electronic

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converters that contribute to cost, size and failure rate on a considerable scale (6). The linearization of cluster voltage control for decoupled control system of CHB based STATCOM is presented in (7) . CHB multilevel inverter is a best choice for static VAr compensation in medium and high voltage applications. This method consists of several capacitors to provide dc link voltage support for H-bridge inverters. This system presents a novel and simple control strategy for a five level cascaded H-bridge multilevel STATCOM (8).

II. METHODOLOGY

In this paper, the STATCOM application using multilevel Inverter is developed . STATCOM is a VSC that it converts DC into AC to compensate real and reactive power. In a conventional STATCOM normal Inverter is used . In the proposed system STATCOM with CHB 5 level Inverter is presented. The performance of PI controller based STATCOM depends on the proper selection of controller gain in a specific operating condition. However for wide range of operating conditions, there is a difficulty in selecting controller gain to achieve the error to zero. This problem of the gain selection easily overcome by the ANFIS based controller (9).

The proposed system is based on ANFIS Controller. The ANFIS is introduced by J.JANG in 1993. The ANFIS is a class of adaptive networks and it function like fuzzy Inference system to follow the input and output data. The Neuro Adaptive Learning techniques calculate the membership functions which allow the related fuzzy inference system .The ANFIS employs an hybrid Learning Algorithm to distinguish the Sugeno type fuzzy inference system. The hybrid learning rule is a combination of the gradient descent technique and Least Square estimator The block diagram of existing system with PI controller based CHB multilevel inverter is shown figure1

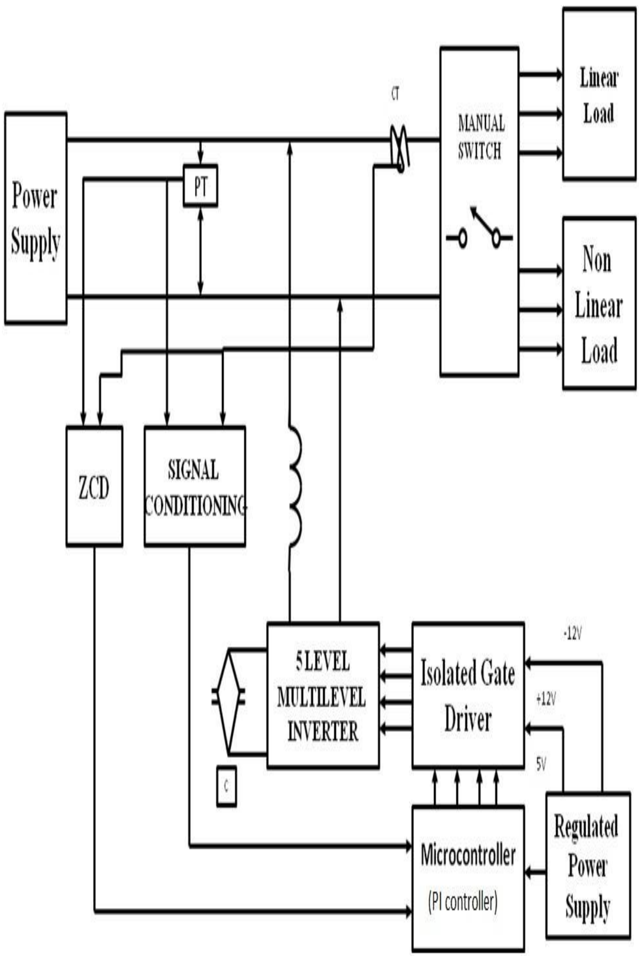

Fig1: Block Diagram of existing system

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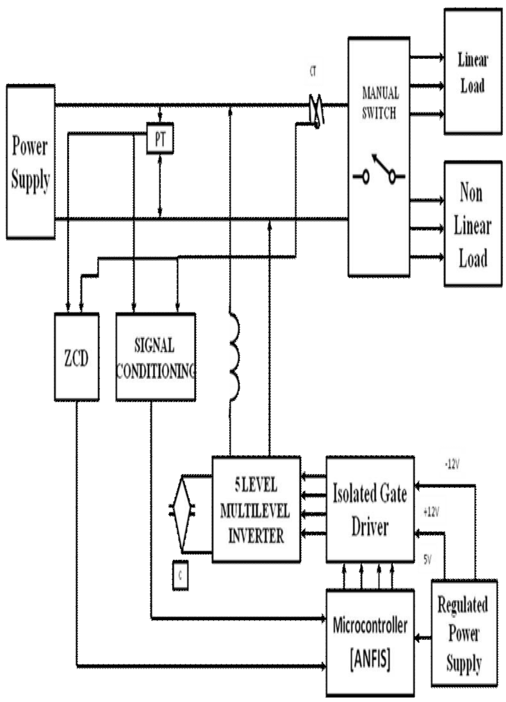

Fig 2: Block Diagram of proposed system ANFIS controller

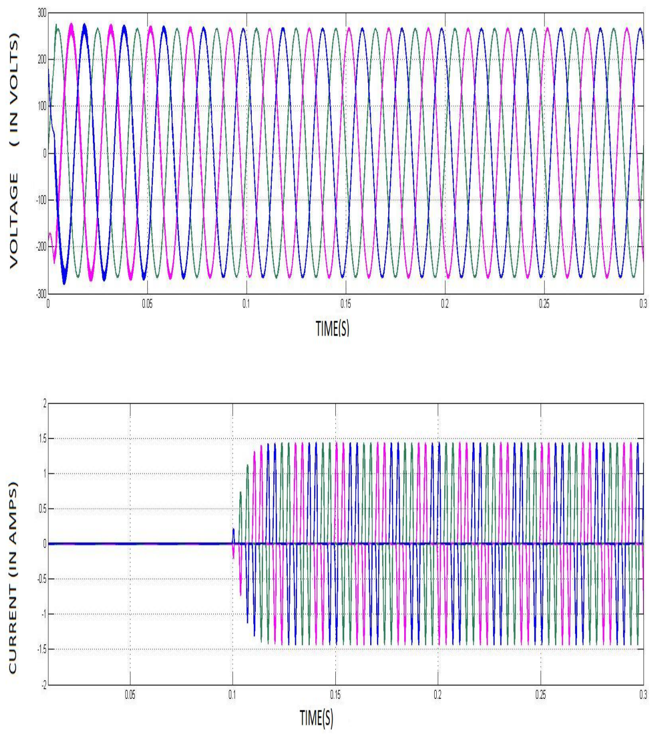

Fig 4: Input voltage and Current for the existing system without compensation

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III. SIMULATION RESULTS

A. EXSISTING SYSTEM (WITHOUT COMPENSATION)

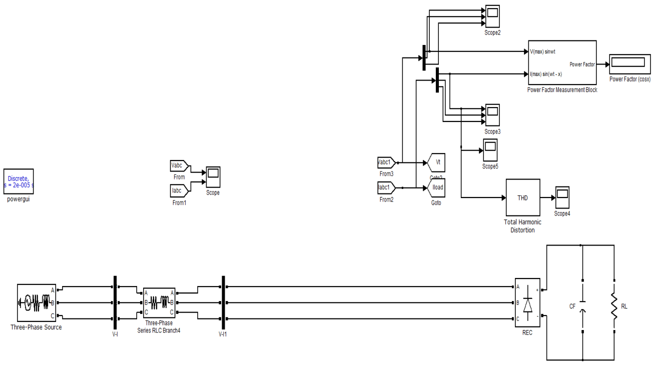

Fig 3: Simulation diagram for existing system (A without compensation)

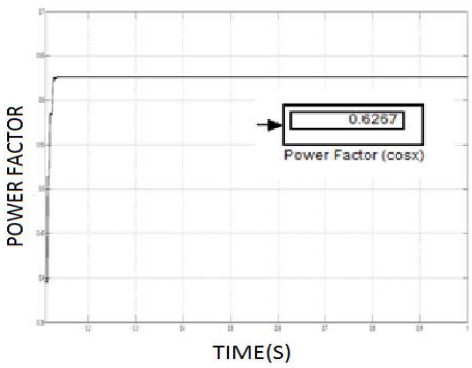

Fig 5: p.f for existing system without compensation

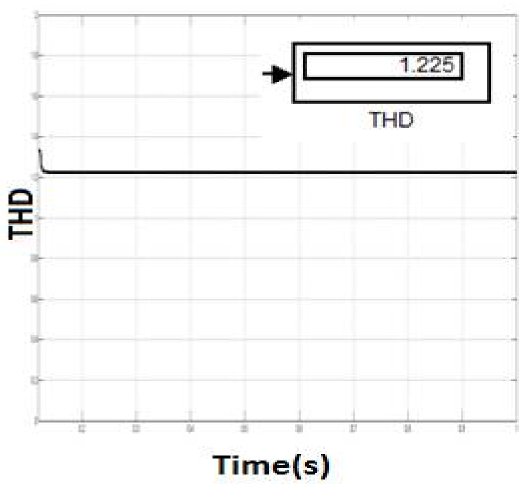

Fig 6: THD for existing system (A without compensation)

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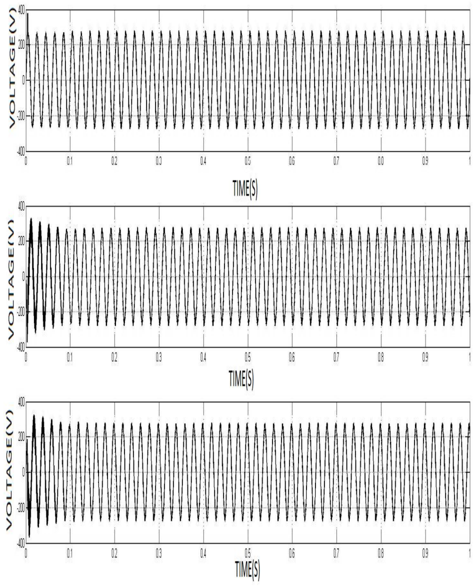

Fig 7: Output voltage for existing system (A without compensation

SIMULATION RESULTS FOR WITH COMPENSATION USING PI CONTROLLER (EXSISTING SYSTEM)

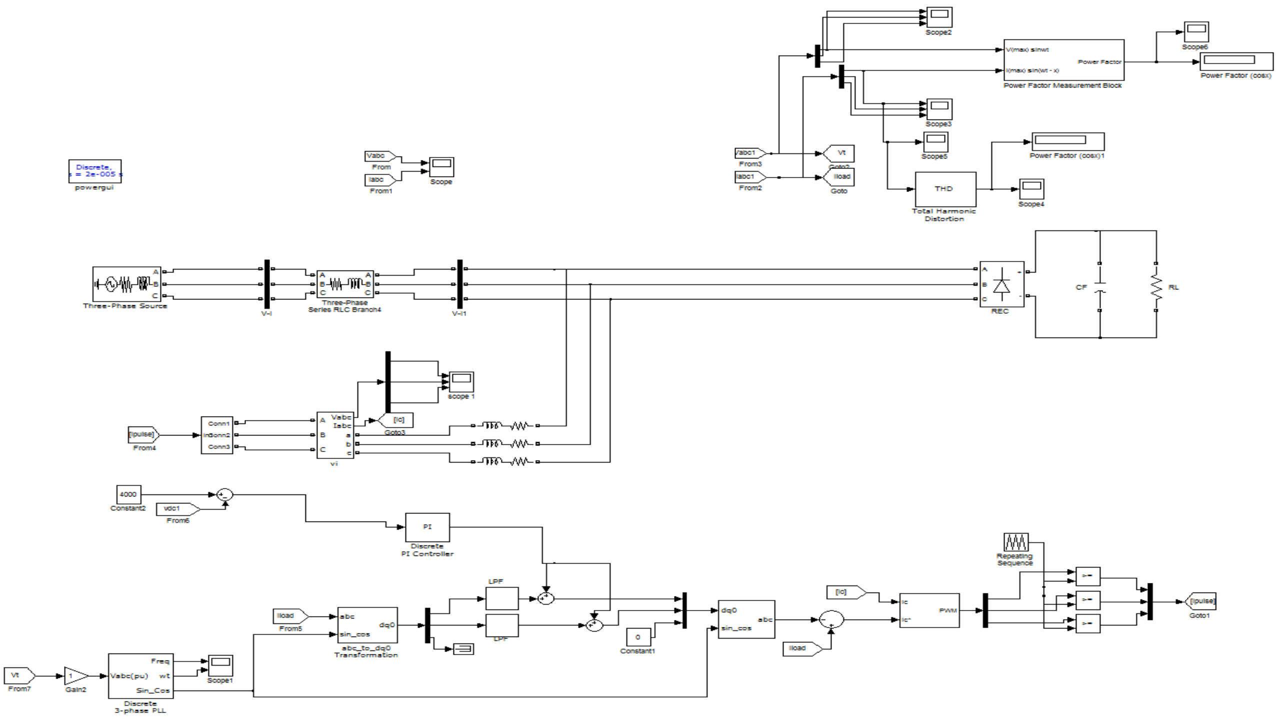

Fig 8: Simulation diagram for existing system (PI controller)

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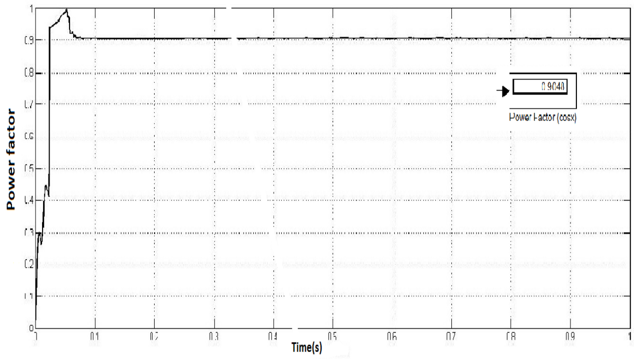

Fig 9: Power factor for existing system PI controller

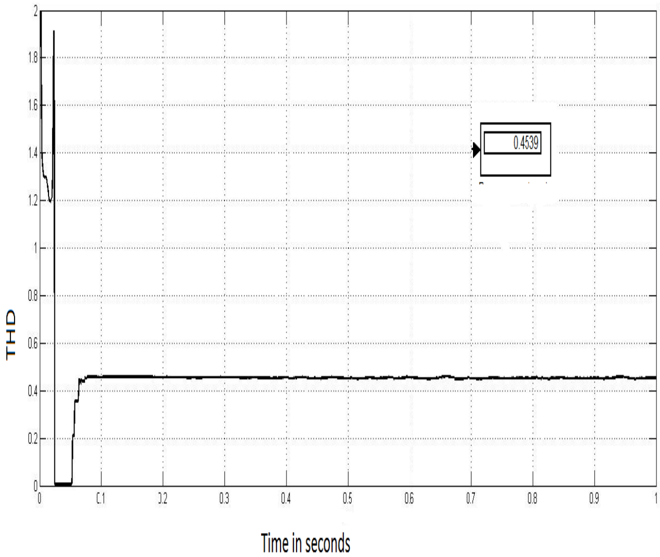

Fig 10.T.H.D for existing system (PI controller)

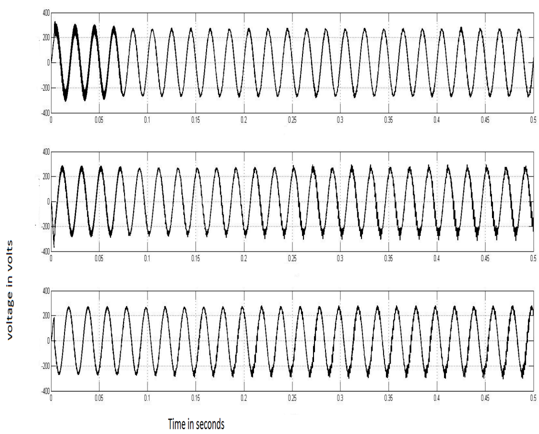

Fig 11: Output voltage for existing system (PI controller)

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ANFIS BASED STATCOM WITH CHB MULTI LEVEL INVERTER (PROPOSED SYSTEM)

In the proposed system DC link voltage is compared with actual voltage and the resulting error signal is the present error The present error is compared with previous error which is stored in memory and the resulting change in error is given as input to the ANFIS logic . Depending upon the change in error signal it produce the output response. The load terminal voltage (Vt) is given to the phase locked loop logic circuit. The PLL circuit splits up the input voltage into unit voltage template three phase load currents are transformed into to two phase transformation. The dq component is given to a low pass filter where the oscillations are damped out .The low pass filter output and ANFIS output are added. The resulting output is converter into two phase to three phase transformation This value of current is compared with actual load current and the resulting error signal is taken as Ic*. It is compared with STATCOM current Ic .By comparing these current a PWM pulse is generated. This PWM signal is then as amplitude signal and it is compared with a carrier signal This will generate Impulse...To obtain controlled 5 level output voltage Impulse and sine wave pulse with modulation output are undergone AND operation. .The resulting signal is applied to the triggering circuit of CHB multilevel inverter

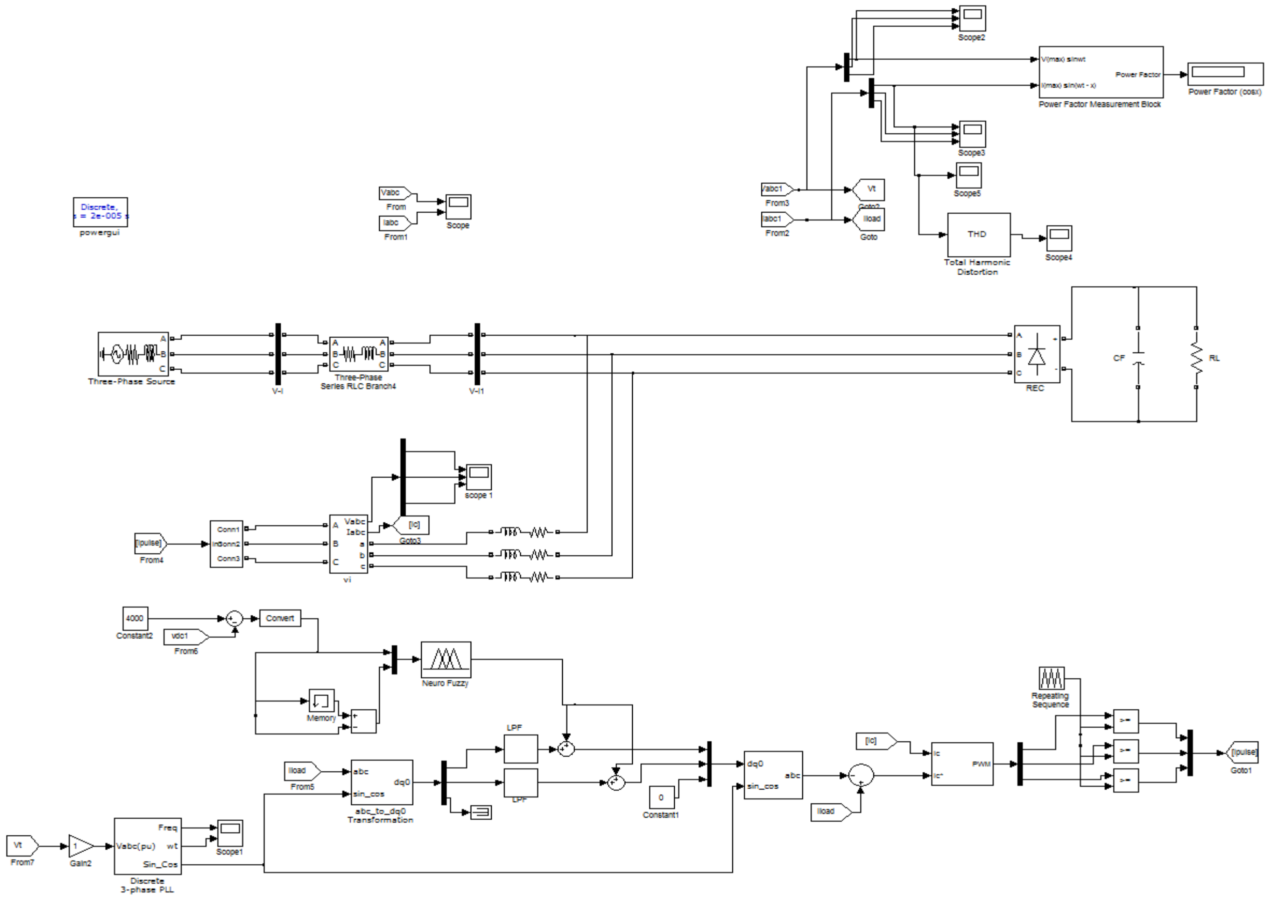

Fig.12: Simulation diagram proposed system (ANFIS controller)

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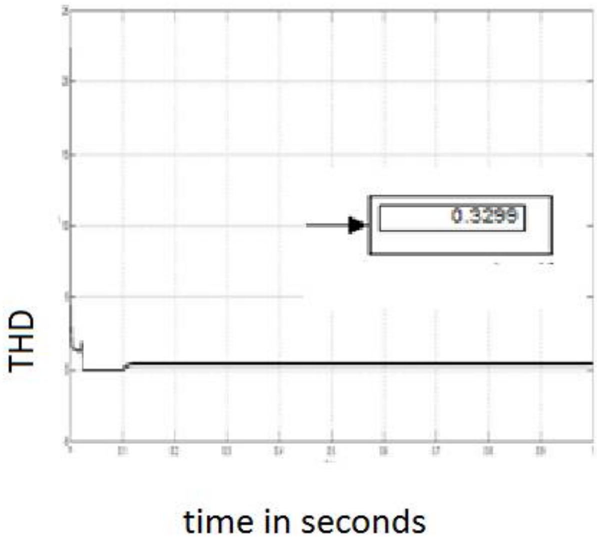

Fig 13. T.H.D for proposed system (ANFIS controller)

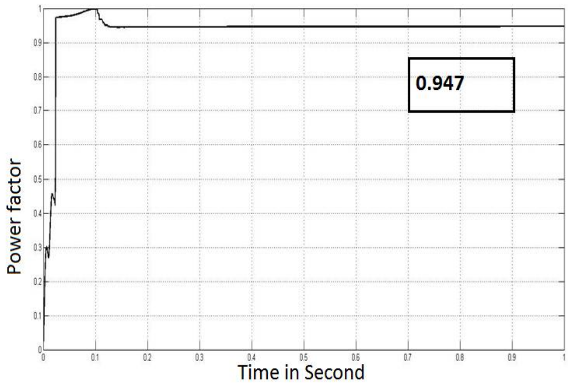

Fig.14. p.f for existing system (ANFIS controller)

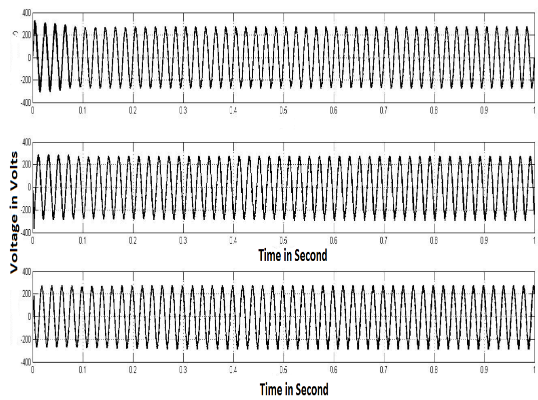

Fig 15: Output voltage for proposed system(ANFIS controller)

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Table 1: Comparative study

Power Quality	Without compensation	With PI Controller STATCOM	With ANFIS based STATCOM
P.F	0.6267	0.9048	0.947
THD	1.225	0.4539	0.3299
Voltage	220v	240v	260v

IV. CONCLUSION

Simulation results shows the ANFIS based CHB multilevel inverter STATCOM improves the power quality.This will gives better harmonic performance. From the simulation results it is proved that the proposed system is best suited for reactive power compensation. A comparative study is performed among the following 1.Without compensation 2. Compensation with PI controller 3.Compensation with ANFIS controller. It is concluded that the PI controller requires fine tuning of the gain to give the error signal as zero. Simulation results proved that the ANFIS based CHB multilevel STATCOM gives better results.

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