DESIGN RECTIFIER FOR HIGH OUTPUT CURRENT

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ABSTRACT: *The application of electrical circuits in various electrical equipment is common nowadays. The power supply unit plays an essential role in any electronic circuit. High current high power converter is very important converter in industries. Most industries used an AC / DC converter for various applications. These converters are power electronic circuits which are further classified as step-down and step-up converters, voltage stabilization circuits, AC to DC converter circuits, DC to DC, DC to AC and so on. Usually, we observe a circuit from which the utility power is taken, and this circuit is used to control the power. There are a number of applications which require a high power requirement at high current. So this article is an attempt to design high current high power rectifier. Two cases considered in this article, one for the single-phase and the second for the three-phase system. This article has discussed eight and twelve pulse IGBT rectifier units used for oil and gas turbine control panel application. This efficient AC to DC converter converts up to 125V, 300A DC. The current controller is used to control the current as needed. In this project, the eight pulse rectifiers and twelve pulse rectifiers are designed for high current and high power applications. The results are compared to the topology of the boost converter*

Keywords – Source, Rectifier, Boostconverter, Three Phase Transformer,Single Phase Transformer,Load

INTRODUCTION - High power, high current thyristor driven rectifiers are widely used in various industrial applications, especially in electrolysis processes. It is also used in turbine control panel testing, electroplating hydrogen production, and several electrochemical processes. Another special application of these rectifiers includes metallurgical processes and nuclear reactors. For several years, diode and thyristor rectifiers have been used in large current rectifiers. These proven diode and thyristor systems are very cost effective and reliable. Their performance is also good. These advantages become more evident in the higher current rectifier system [1]. In recent years, voltages and current are improved using insulated gate bipolar transistors, i.e. IGBTs. IGBTs are used to deactivate the switching device in power rectifiers.

There are several efforts to apply IGBT technology in a high power rectifier system [2]. Disclosed is a step-up converter which uses a combination of unregulated diode rectifier and step-down, DC / DC converter and to achieve such a desired output [3] [4]. As the load current demand of the installation increases, the required number of parallel IGBTs and its switching cell also increases. Since the requirement is more current demand, the system design should be suitable, durable, and the switching frequency can also work well.

This problem reduced the productivity and the life of the equipment. The electromagnetic coupling with the neighboring structure leads to heating of the device and an increment of loss [4]. The development of a high current switching and shutdown device and its application requires high current. Integrated gate bipolar thyristors are characterized by certain performance parameters. The manufacturers specify these parameters which are the collector emitter blocking voltage, the emitter collector blocking voltage and the gate emitter voltage. Important IGBT ratings are values that establish a minimum carrying capacity and limiting condition. IGBTs cannot operate beyond the maximum or minimum rated value, which is determined for a specified operating point and environmental condition. The maximum current rating of an IGBT is much higher than a MOSFET and a reliable converter for cutting off IGBT signals is used in industrial medium voltage drives as well as in the power management system [5].

The power supply has become a basic need in our everyday life, the power we have is a 230V 50Hz AC power supply. But, by using power electronics conversion circuits, this power can be converted into the required shape and range. These converters are power electronic circuits which are further classified as step-down and step-up converters, voltage stabilizer circuit, AC to DC, DC to DC, DC to AC conversion circuits and so on. In general, one can observe a circuit from which the mains power is taken, and this circuit is used to control the power delivered to the load. Therefore, this circuit can be referred to as a power supply circuit, and there are different types of power supply circuits such as switching power supply, variable power supply, DC regulated power supply, etc., which are classified according to of various criteria. Due to the rapid development of the electronics industry and the growing awareness of energy saving and reducing carbon emissions, high conversion efficiency

and compact size of the volume is an inevitable trend. The power converter will evolve into a newer and more advanced switching power converter.

SYSTEM CONFIGURATION

1 BY USING BOOST CONVERTER -

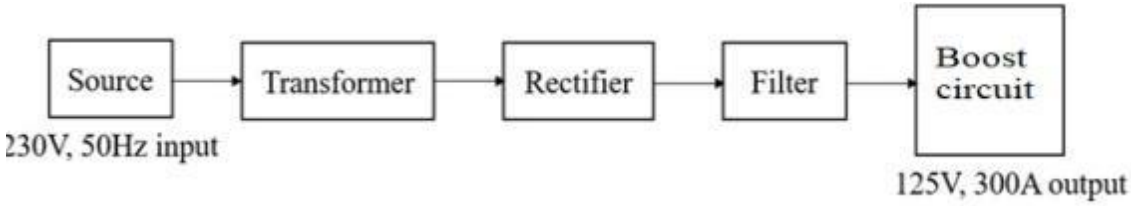

Fig. 1 Boost converter circuit

The outline of the AC DC support converter is appeared in figure (1). It comprises of a 230V 50 Hz input source. This info is then associated with the progression down transformer. The progression down transformer diminishes the voltage. The capacitor likewise utilized for sifting music and furthermore decreases pressure. Rectifiers having an extension diode are associated. It works like setting off the beat that gives substituting current to coordinate current. A rectifier connect is utilized, it is a typical piece of electronic force supplies. An extension rectifier is an exchanging current to coordinate current converter. In the force converter, the progression up converter capacitor is utilized for the channel. The beat yield of the rectifier has a normal DC esteem and an AC part called the wave voltage. On the off chance that the necessary yield current is more than 10A, at that point it will be helpful to expand the current by utilizing the arrangement of two lift converters. This will expand the current to the ideal yield varying. The two lift converters utilized in burden to expand voltage and current.

Usually a bridge rectifier is used. A bridge rectifier circuit is a common part of electronic power supplies. A bridge rectifier is an AC to DC converter that rectifies the AC input from the mains to the DC output. Extension rectifiers are generally utilized in power supplies that give the DC voltage required by electronic segments or gadgets. They can be developed with at least four diodes or some other controlled strong state switch. Contingent upon the heap current prerequisites, a suitable extension rectifier is chosen.

2 BY USING SINGLE PHASE EIGHT PULSE CONVERTER:

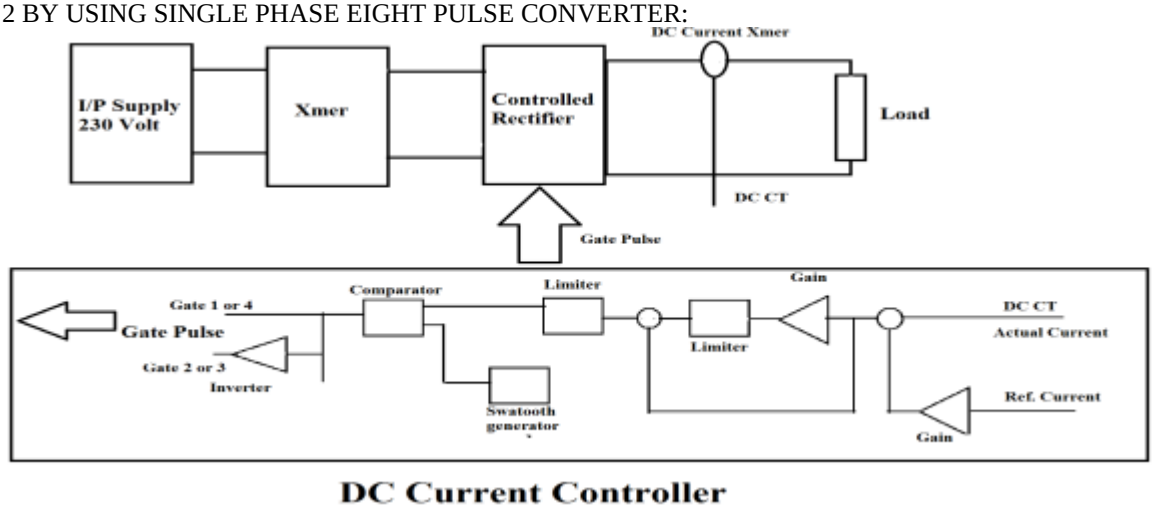

Fig 2 Eight pulse controlled rectifier

The figure (2) is the block diagram of eight pulse converter. t begins with the info flexibly for example 230V single stage 50 Hz Air conditioning which is taken care of to the liner transformer. The transformer is utilized as step down transformer which is venture down the voltages. At that point this transformer is associated with the controlled rectifier. The offended door bipolar thyristor IGBT is utilized for the rectifier framework. Eight heartbeat rectifier is utilized for the change. The beats is made by utilizing the contrary extremity. The simple control framework is used for accomplishing control of current and force at the set qualities. The ordinary stage edge control arrangement of thyristors has been executed to keep up yield current and force. The current regulator is utilized to control current qualities. Also, it gives the beats to the thyristors. To control the thyristors heartbeats and gives the ideal yield. Resistive burden is utilized.

3 BY USING TWELVE PULSE CONTROLLED RECTIFIER-

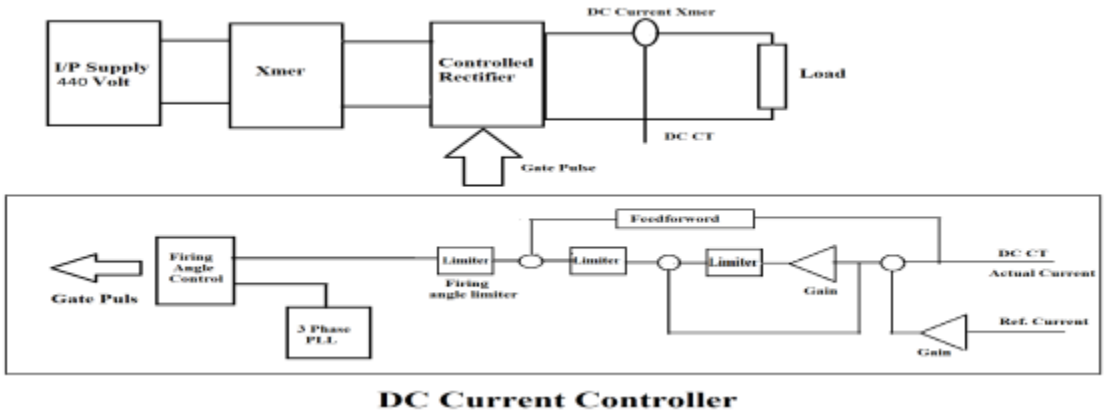

Fig 3 Twelve pulse three phase controlled rectifier

Consider the current and force necessities of the test and the commitment of every rectifier unit, all rectifier units must be parametric estimations of these rectifier units acquired after assembling and resulting testing must match. The force circuits of the thyristor rectifier frame work incorporate a rectifier transformer. The evaluated current is 300 amps on the yield side. The circuit setup of the thyristor rectifier framework is appeared in fig. To meet the high yield direct current necessity, two optional windings of the rectifier transformer flexibly different sides. The star-delta rectifier transformer is utilized. Completely controlled thyristor spans which are associated in corresponding with the twelve heartbeat yield. The twelve-beat setup was picked to diminish yield voltage wave and abatement complete consonant bends (THD). The two thyristors can share the branch current.

The rectifier transformer has three windings. The high voltage essential winding is associated in delta while the other two low voltage auxiliary windings. One is delta and the other is star with a stage move of 300 degrees to the twelve pulse arrangement.

METHODOLOGY

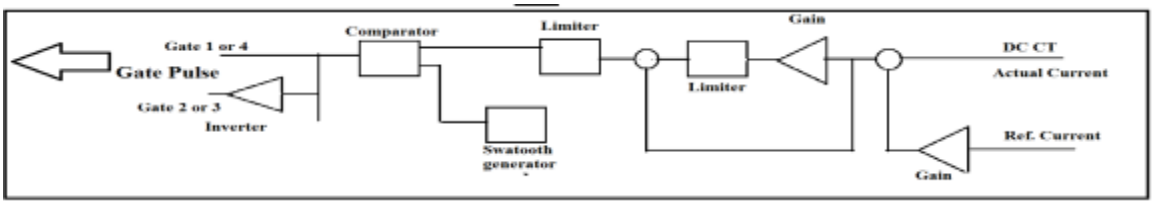

Fig 4 Current controller

Current controller

The current controller is shown on the PI regulator. The controller controls the armature current by figuring the proper thyristor terminating point. This produces the rectifier yield voltage important to acquire the ideal armature current and along these lines the ideal electromagnetic force. The regulator takes the current reference. In this control system, the enactment and deactivation of the converter relies upon the estimation of the heap current. The two set qualities are put away, for example the base and most extreme estimation of the charging current.

The equation used by the DC controller block to calculate the reference voltage is

$$v_{ref} = K_P + K_i(\frac{T_s z}{z-1})(i_{ref} - i)$$

where, is the reference voltage, is the proportional gain, is the integral gain, is the sampling time, is the reference current, is the measured current

The PI control calculation is changed to zero and in a closed loop transfer function to cancel the zero. The block uses the discrete time zero cancel transfer function

$$G_{zc}(z) = \frac{\frac{T_s K_i}{K_p}}{z + (\frac{T_S - \frac{K_p}{K_i}}{\frac{K_p}{K_i}})}$$

To avoid saturation of the integrated output, the block uses an anti-winding mechanism. The gain of the integrator is equal to

$$K_i + K_{aw}(v_{ref\ sat} - v/_{ref\ unsat})$$

where, K_{aw} is anti windup gain, $v_{ref\ sat}$ is the saturated reference voltage signals which block calculate and $v_{ref\ unsat}$ is the unsaturated reference voltage signal.

CALCULATION

Calculation of maximum switch current

Efficiency 0.9

Duty cycle

Inductor ripple current

$d_i = 2 \times I \times (V_{OUT} \div V_{in})$

dv=05.

The duty cycle is calculated as follows

D=1- $\frac{V_{in}}{V_{out}}$ = 55

Where Vin is the input voltage and Vout is the output voltage

Capacitor value is

$c = I \times D \div (f_s \times d_v)$ = 0.33μF

The load R is given by

R=V_{out}/I = 4Ω

The inductor value is designed

L= $\frac{DV_{in}}{f\Delta i_L}$ = 3.89 μH

The calculation for the maximum switching current will be set to all parameters. The duty cycle can be changed depending on the input voltage and the output voltage. As the duty cycle increases, the voltage output changes. The value of the output capacitor will light up using this formula. The value of the capacitor increases the value of the output current. The deflection angle is 0.5.

Single phase rectifier design

$V_{DC} = \frac{1}{T}\int_0^T V_L(t)dt = \frac{2}{2\pi}\int_0^\pi V_S \sin(wt)dt$ 4.4.1

$$V_L = \sqrt{\frac{1}{T}\int_0^T V_L^2 \times (t)dt} = \sqrt{\frac{1}{\pi}\int_0^\pi V_L^2 \times \sin(wt)^2\, dt} \quad 4.4.2$$

$$I_{DC} = \frac{V_{DC}}{R_L} = \frac{2 \times V_S}{\pi \times R_L} \quad 4.4.3$$

$$\mathrm{I_L} = \frac{\mathrm{V_L}}{\mathrm{R_L}} = \frac{\mathrm{V_S}}{\sqrt{2 \times \mathrm{R_L}}} \quad 4.4.4$$

$$\mathrm{FF} = \frac{\mathrm{V_L}}{\mathrm{V_{DC}}} \quad 4.4.5$$

$$\mathrm{n} = \frac{1}{\mathrm{FF}}^2 \quad 4.4.6$$

$$\mathrm{RF} = \sqrt{\mathrm{FF}^2 - 1} \quad 4.4.7$$

$$\mathrm{TUF} = \frac{\mathrm{V_{DC}} \times \mathrm{I_{DC}}}{\frac{\mathrm{V_S}}{\sqrt{2}} \times \frac{\mathrm{I_S}}{\sqrt{2}}} \quad 4.4.8$$

Parameters of eight pulse rectifier :

Parameter	**Values**
Input supply	230V 50Hz
Output current	300 A
Output voltage	125V

Output power	37.5 KW
Rated load	54%
Configuration	Eight pulse controlled rectifier
Control element	insulated gate bipolar transistors IGBT
Output ripple	Less than 4% at rated output voltage
Current stability	+0.5%,-0.5 % of set value
Regulation	+0.5%,-0.5 % of set value
Response time	Better 100 m sec

Three phase transformer design

Delta connection

Phase voltage $V_p = V_L$, Line voltage $V_L = V_P$

Phase current $I_p = I_L \div \sqrt{3}$, Line current $I_L = \sqrt{3} \times I_P$

Star connection

Phase voltage $V_p = V_L \div \sqrt{3}$, Line voltage $V_L = \sqrt{3} \times V_P$

Phase current $I_p = I_L$, Line current $I_L = I_P$

Rectifier transformer sizing calculation

Hence for the three phase thyristor bridge load current per bridge is given below

I_{L1}=I_{L2}= 300/2 =150A

Secondary RMS line current can be evaluated as $I_{2RMS} = I_{L1}$

Further , transformer secondary delta winding line voltage ,$V_{2RMS} = \{V_L + V_{TH} + bus\ bar\ drop\}/1.35$

Where the load voltage is 125volt thyristor voltage drop is 1.5 volt

Parameters of twelve rectifier

Parameters	Values
Vdc, VL	206.74V,206.87V
Form factor	0.679
Rectification ratio	0.95
Ripple factor	0.043
Current in each sec. winding	234.11A
Current through a diode	165.45A
TUF	1.700

SIMULATION-

Simulation of boost current circuit rectifier, Eight pulse controlled rectifier, Twelve pulse controlled rectifier and there simulation results.

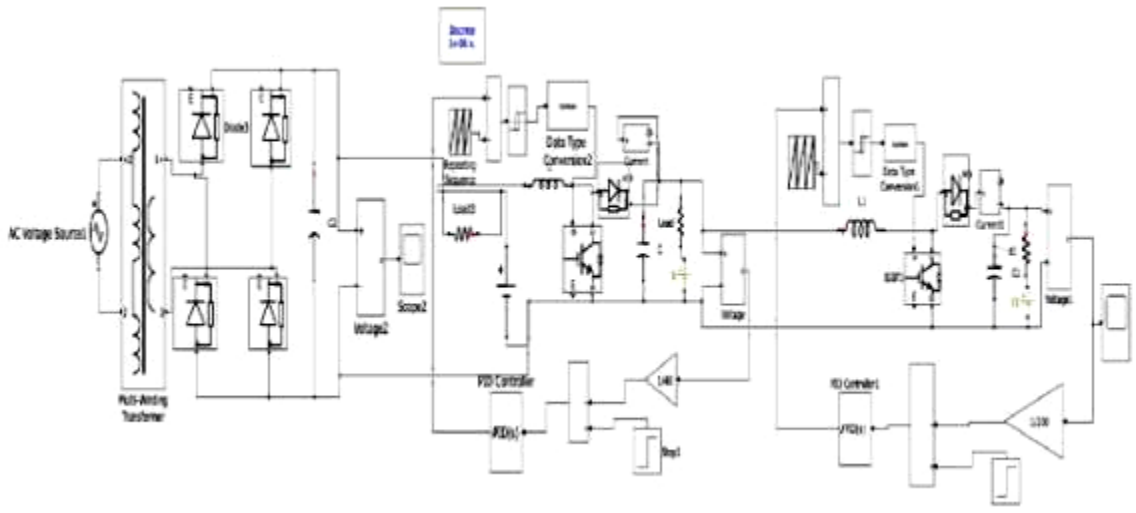

Fig 5 Simulation of using boost current circuit

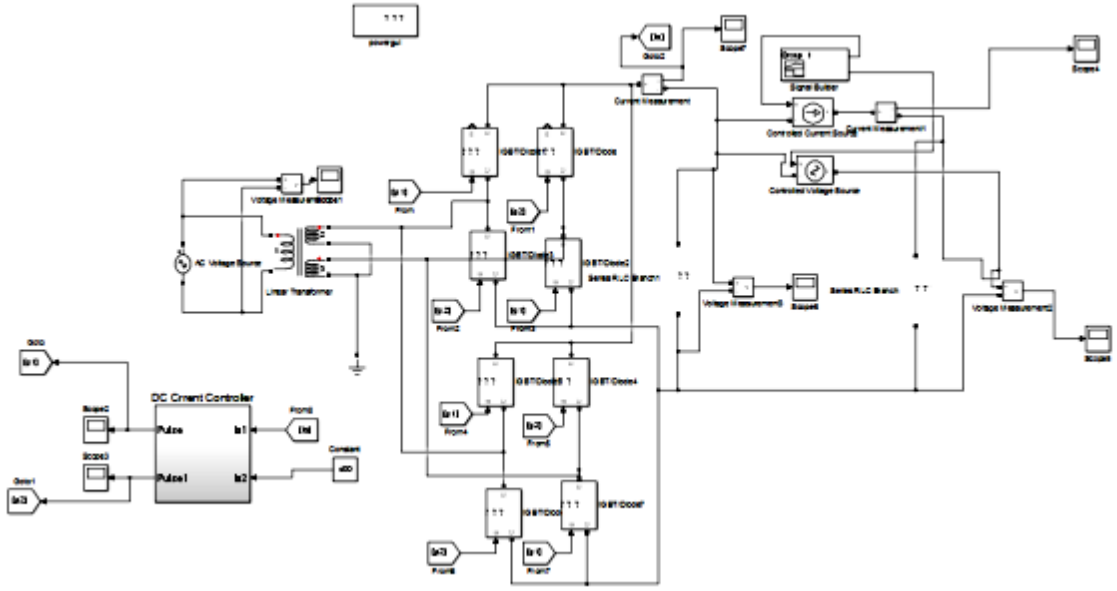

Fig 6 Simulation of Eight pulse controlled rectifier

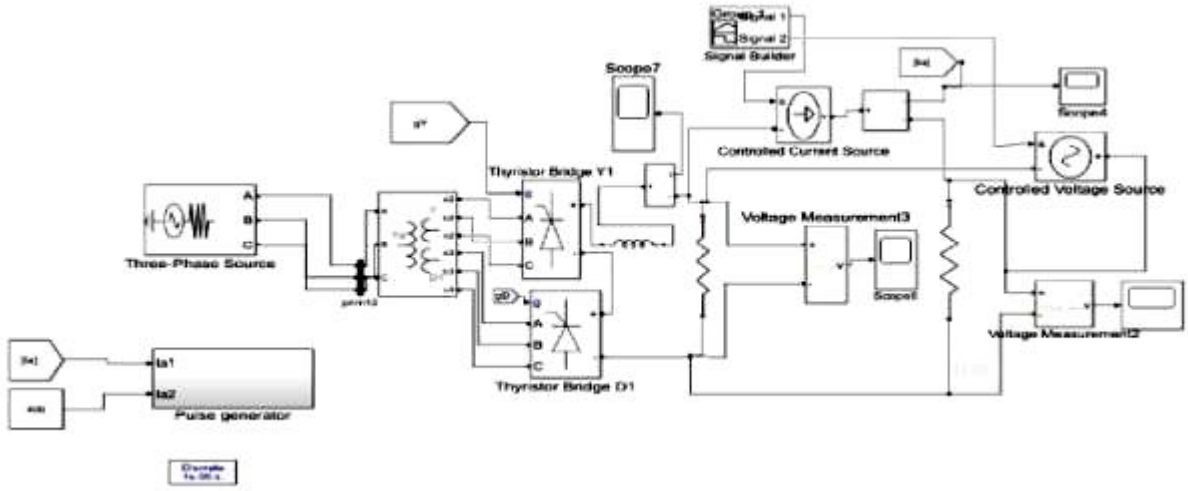

Fig 7 Simulation of twelve pulse controlled rectifier

SIMULATION RESULT-

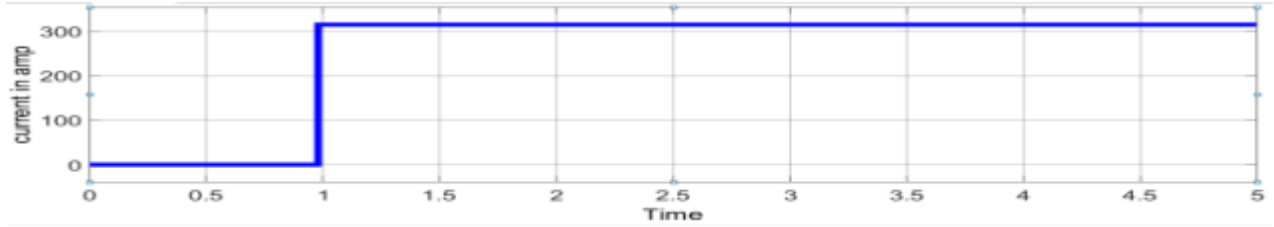

Fig 8 Output of current using boost boost converter

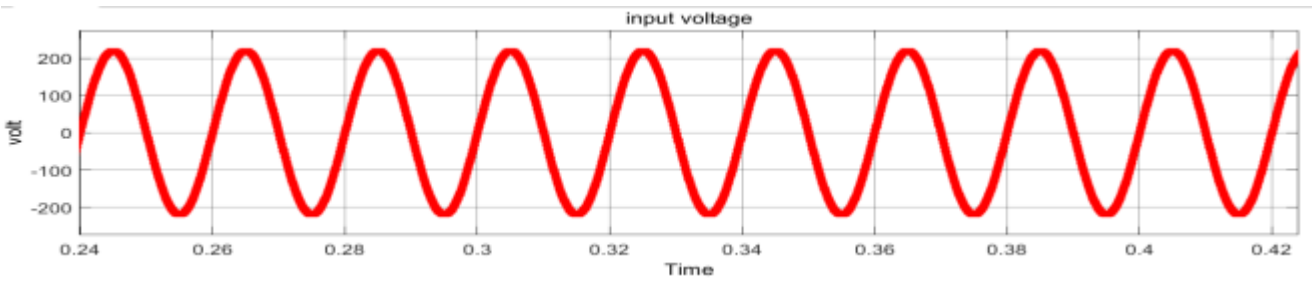

Fig 9 Input voltage of eight pulse controlled rectifier

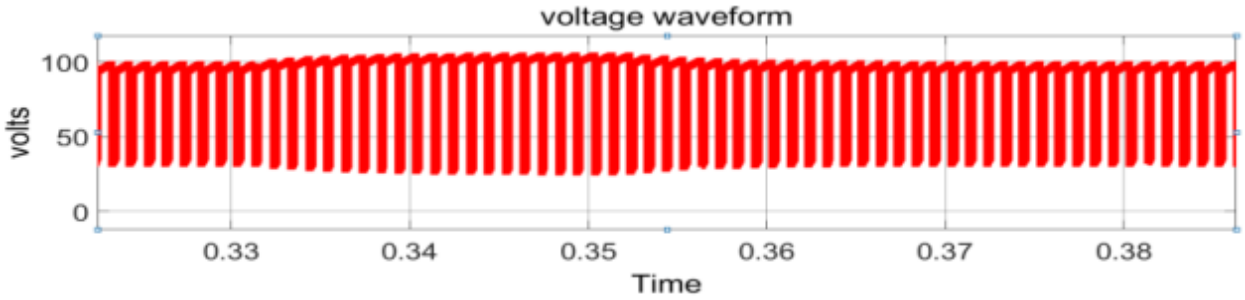

Fig 3output voltage of eight pulse controlled rectifier

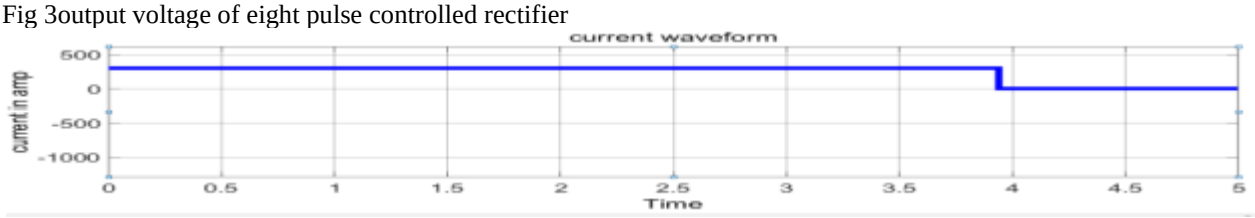

Fig 4 output current of twelve pulse controlled rectifier

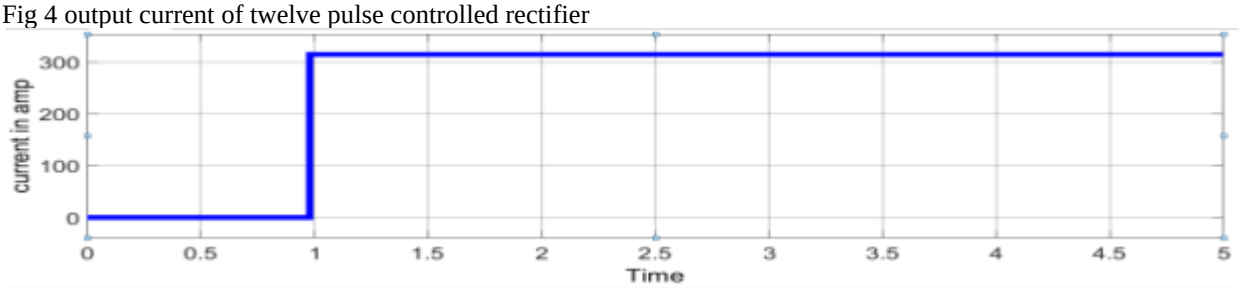

Fig 5 output current of twelve pulse controlled rectifier

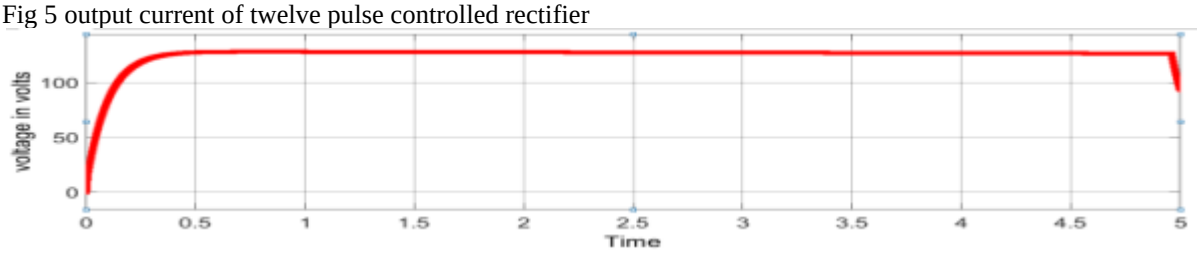

Fig 6 output voltage of twelve pulse controlled rectifier

CONCLUSION- As ac dc converter consists of 230V 50 Hz input source. This input is then connected to step down transformer. Step down transformer reduces voltage. The capacitor also used for the filtering the harmonics and also reduces the stress. Rectifier having bridge diode are connected. It works as the triggering of the pulse which gives the ac to dc. A bridge rectifier is used it is a common part of the electronics power supplies. A bridge rectifier is an alternating current to direct current converter. In power converter the boost converter capacitor is used for the filter. The pulsating output of the rectifier has an average dc value and ac portion that is called ripple voltage. If the output current requirement is more than 10 amp, then it will conveninent to boost the current using the series of two boost converter. It will increase the current upto desired output which we require. The two boost converter usedin load side for boosting the voltage and current. A rectifier is an electrical device that converts alternating current(AC), which periodically reverses direction , to direct current (DC),which flows in only one direction. Depending on the type of alternating current supply and the arrangement of the rectifier circuit, the output voltage may require additional smoothing to produce a uniform steady voltage. Many application of rectifier , such as power supplies for radio ,television and computer equipment ,require a steady constant DC voltage. In this application the output of the rectifier is smoothed by an electronic filter, which maybe a capacitor choke, or set of capacitor , chokes and resistors ,possibly followed by a voltage regulator to produce a steady voltage. To achieve such a high current rating , we can find methods for improving for desired output and cost reduction , effiecient for purpose. This waveform clearly shows the output of voltage and current.The proposed solution generates a relatively smooth output dc current with less contents of high-frequency harmonics. This paper gives the idea about the large current output rectifier design. Large current rectifier can used in large current application.By using different design consideration of high current high power rectifier, eight pulse IGBT rectifier units utilized for oil and gas turbine control panel application have been discussed .An efficient AC –DC converter that will convert upto 125V,300A DC. The current controller to control current as per requirement. In this project transformer is used for step down the voltages and after this used rectifier circuit for conversion of AC to DC and then we used

current controller for achieving the desired output current and voltage . we can be achieved such system in hardware.

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