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A Review of Study and Analysis of Power Quality Improvement of DC Drives

[1]Rashi Goswami, [2]Anand Goswami

[1]Research scholar, Fourth Semester ME (Control System), Jabalpur Engineering College, Jabalpur (M.P) 482011, India
[2]ME (Control System), Jabalpur Engineering College, Jabalpur (M.P) 482011, India

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Abstract: **The paper presents a review of power quality improvement of DC drives. Because of power quality should be improved for electrical devices, hence the multipulse converter are connected with DC drives and run at no load condition. FFT analysis are performed and Total Harmonic Distortion (THD) results, which are obtained by different parameter. The use of solid-state converters in various applications, as DC drives, variable frequency drives (VFD), heating and lighting industries, shipping (transportation) industry.**

Keywords: **Three phase power supply, performing Parameters, D.C. drive.**

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1. INTRODUCTION

Three-phase full-wave Controlled Rectifier with highly inductive load Voltage and current waveforms of a three-phase full converter with a highly inductive load. A Bridge rectifier is an Alternating Current (AC) to Direct Current (DC) converter that rectifies mains AC input to DC output. Bridge Rectifiers are widely used in power supplies that provide necessary DC voltage for the electronic components or devices. They can be constructed with four or more diodes or any other controlled solid state switches.

Depending on the load current requirements, a proper bridge rectifier is selected. Components' ratings and specifications, breakdown voltage, temperature ranges, transient current rating, forward current rating, mounting requirements and other considerations are taken into account while selecting a rectifier power supply for an appropriate electronic circuit's application.

2. THREE-PHASE RECTIFIERS

Single-phase rectifiers are commonly used for power supplies for domestic equipment. However, for most industrial and high-power applications, three-phase rectifier circuits are the norm. As with single-phase rectifiers, three-phase rectifiers can take the form of a half-wave circuit, a full-wave circuit using a center-tapped transformer, or a full-wave bridge circuit.

Thyristors are commonly used in place of diodes to create a circuit that can regulate the output voltage. Many devices that provide direct current actually generate three-phase AC. For example, an automobile alternator contains six diodes, which function as a full-wave rectifier for battery charging.

3. TYPES OF BRIDGE RECTIFIERS

Bride rectifiers are classified into several types based on these factors: type of supply, controlling capability, bride circuit's configurations, etc. Bridge rectifiers are mainly classified into single and three phase rectifiers. Both these types are further classified into uncontrolled, half controlled and full controlled rectifiers. Some of these types of rectifiers are described below.

Single Phase and Three Phase Rectifiers:

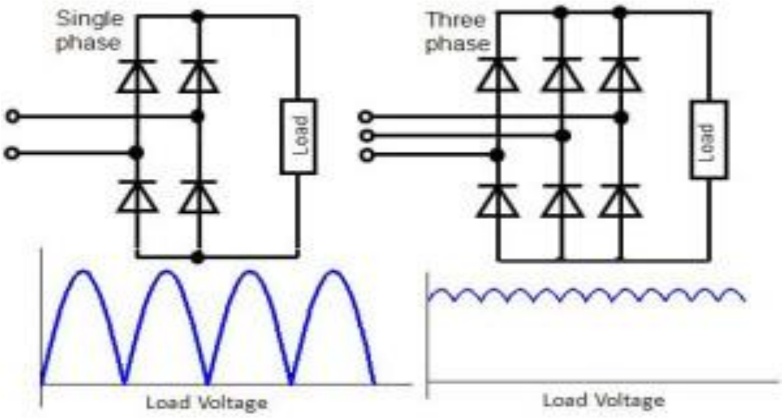

Figure.1. Single Phase and Three Phase Rectifiers

The nature of supply, i.e., a single phase or three-phase supply decides these rectifiers. The Single phase bridge rectifier consists of four diodes for converting AC into DC, whereas a three phase rectifier uses six diodes, as shown in the figure. These can be again uncontrolled or controlled rectifiers depending on the circuit components such as diodes, thyristors.

4. HVDC CONVERTER

An **HVDC converter** converts electric power from high voltage alternating current (AC) to high-voltage direct current (HVDC), or vice versa. HVDC is used as an alternative to AC for transmitting electrical energy over long distances or between AC power systems of different frequencies. HVDC converters capable of converting up to two gigawatts (GW) and with voltage ratings of up to 900 kilovolts (kV) have been built, and even higher ratings are technically feasible. A complete converter station may contain several such converters in series and/or parallel.

Almost all HVDC converters are inherently bi-directional; they can convert either from AC to DC (rectification) or from DC to AC (inversion). A complete HVDC system always includes at least one converter operating as a rectifier (converting AC to DC) and at least one operating as an inverter (converting DC to AC). Some HVDC systems take full advantage of this bi-directional property (for example, those designed for cross-border power trading, such as the Cross-Channel link betweenEngland and France). Others, for example those designed to export power from a remote power station such as the Itaipuscheme in Brazil, may be optimised for power flow in only one preferred direction. In such schemes, power flow in the non-preferred direction may have a reduced capacity or poorer efficiency. HVDC converters can take several different forms. Early HVDC systems, built until the 1930s, were effectively rotary converters and used electromechanical conversion with motor-generator sets connected in series on the DC side and in parallel on the AC side. However, all HVDC systems built since the 1940s have used electronic (static) converters.

5. LINE-COMMUTATED CONVERTERS

Most of the HVDC systems in operation today are based on line-commutated converters (LCC). The term line-commutated indicates that the conversion process relies on the line voltage of the AC system to which the converter is connected in order to effect the commutation from one switching device to its neighbour. Line-commutated converters use switching devices that are either uncontrolled (such as diodes) or that can only be turned on (not off) by control action, such asthyristors. Although HVDC converters can, in principle, be constructed from diodes, such converters can only be used in rectification mode and the lack of controllability of the DC voltage is a serious disadvantage. Consequently, in practice all LCC HVDC systems use either grid-controlled mercury-arc valves (until the 1970s) or thyristors (to the present day).

In a line-commutated converter, the DC current does not change direction; it flows through a large inductance and can be considered almost constant. On the AC side, the converter behaves approximately as a current source, injecting both grid-frequency and harmonic currents into the AC network. For this reason, a line-commutated converter for HVDC is also considered as a current-source converter. Because the direction of current cannot be varied, reversal of the direction of power flow (where required) is achieved by reversing the polarity of DC voltage at both stations.

6. SIX-PULSE BRIDGE

The basic LCC configuration for HVDC uses a three-phase Graetz bridge rectifier or six-pulse bridge, containing six electronic switches, each connecting one of the three phases to one of the two DC terminals. A complete switching element is usually referred to as a valve, irrespective of its construction. Normally, two valves in the bridge are conducting at any time: one on the top row and one (from a different phase) on the bottom row. The two conducting valves connect two of the three AC phase voltages, in series, to the DC terminals. Thus, the DC output voltage at any given instant is given by the series combination of two AC phase voltages. For example, if valves V1 and V2 are conducting, the DC output voltage is given by the voltage of phase 1 minus the voltage of phase 3.

Because of the unavoidable (but beneficial) inductance in the AC supply, the transition from one pair of conducting valves to the next does not happen instantly. Rather, there is a short overlap period when two valves on the same row of the bridge are conducting simultaneously. For example, if valves V1 and V2 are initially conducting and then valve V3 is turned on, conduction passes from V1 to V3 but for a short period both of these valves conduct simultaneously. During this period, the DC output voltage is given by the average of the voltages of phases 1 and 2, minus the voltage of phase 3. The overlap angle μ (or u) in an HVDC converter increases with the load current, but is typically around 20° at full load. During the overlap period, the output DC voltage is lower than it would otherwise be and the overlap period produces a visible notch in the DC voltage. An important effect of this is that the mean DC output voltage decreases as the overlap period increases; hence the mean DC voltage falls with increasing DC current.

7. TWELVE-PULSE BRIDGE

With a phase change only every 60°, considerable harmonic distortion is produced at both the DC and AC terminals when the six-pulse arrangement is used. An enhancement of the six-pulse bridge arrangement uses 12 valves in a twelve-pulse bridge. A twelve-pulse bridge is effectively two six-pulse bridges connected in series on the DC side and arranged with a phase displacement between their respective AC supplies so that some of the harmonic voltages and currents are cancelled.

The phase displacement between the two AC supplies is usually 30° and is realised by using converter transformers with two different secondary windings (or valve windings). Usually one of the valve windings is star (wye)-connected and the other is delta-connected. With twelve valves connecting each of the two sets of three phases to the two DC rails, there is a phase change every 30°, and harmonics are considerably reduced. For this reason the twelve-pulse system has become standard on almost all line-commutated converter HVDC systems, although HVDC systems built with mercury arc valves usually allowed for temporary operation with one of the two six-pulse groups bypassed.

8. VOLTAGE-SOURCE CONVERTERS

Because thyristors can only be turned on (not off) by control action, and rely on the external AC system to effect the turn-off process, the control system only has one degree of freedom – when to turn on the thyristor. This limits the usefulness of HVDC in some circumstances because it means that the AC system to which the HVDC converter is connected must always contain synchronous machines in order to provide the commutating voltage – the HVDC converter cannot feed power into a passive system.

With some other types of semiconductor device such as the insulated-gate bipolar transistor (IGBT), both turn-on and turn-off can be controlled, giving a second degree of freedom. As a result, IGBTs can be used to make self-commutated converters. In such converters, the polarity of DC voltage is usually fixed and the DC voltage, being smoothed by a large capacitance, can be considered constant. For this reason, an HVDC converter using IGBTs is usually referred to as a voltage-source converter (or voltage-sourced converter[26]). The additional controllability gives many advantages, notably the ability to switch the IGBTs on and off many times per cycle in order to improve the harmonic performance, and the fact that (being self-commutated) the converter no longer relies on synchronous machines in the AC system for its operation. A voltage-sourced converter can therefore feed power to an AC network consisting only of passive loads, something which is impossible with LCC HVDC. Voltage-source converters are also considerably more compact than line-commutated converters (mainly because much less harmonic filtering is needed) and are preferable to line-commutated converters in locations where space is at a premium, for example on offshore platforms.

9. TWO-LEVEL CONVERTER

The two-level converter is the simplest type of three-phase voltage-source converter and can be thought of as a six pulse bridge in which the thyristors have been replaced by IGBTs with inverse-parallel diodes, and the DC smoothing reactors have been replaced by DC smoothingcapacitors. Such converters derive their name from the fact that the voltage at the AC output of each phase is switched between two discrete voltage levels, corresponding to the electrical potentials of the positive and negative DC terminals.

10. DC MOTOR

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

Electromagnetic motors:

A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. The direction and magnitude of the magnetic field produced by the coil can be changed with the direction and magnitude of the current flowing through it.

A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes. (Brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes.)

The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created.The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. Different number of stator and armature fields as well as how they are connected provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems which adjust the voltage by "chopping" the DC current into on and off cycles which have an effective lower voltage.

11. CONCLUSION

This paper presents a review of power quality improvement of DC drives. Because of power quality should be improved for electrical devices, hence the multipulse converter are connected with DC drives and run at no load condition. FFT analysis are performed and Total Harmonic Distortion (THD) results, which are obtained by different parameter. The use of solid-state converters in various applications, as DC drives, variable frequency drives (VFD), heating and lighting industries, shipping (transportation) industry.

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