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STUDY AND ANALYSIS OF VARIABLE FREQUENCY AC DRIVE

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***Abstract*— Abstract- In this situation of each trade we tend to see that power saves and thus price saving activities are occurring to extend margin of profit and to urge fine management of method to achieve optimized quality product. In each trade we discover some common electrical equipments like motors transformers etc. Most of the energy within the industries is employed for motors. Saving of some quantity of energy from every motor will provide USA price saving and thus margin of profit is redoubled. During this paper we tend to are talking concerning the one among the foremost vital power saving tool of industries i.e. Variable frequency drive, its parts and it operating**

Keywords— VFD, EA, M/C, X-mer , VVVF, VSD, AFD etc.

I. INTRODUCTION

As all of you recognize, we tend to move the globe. Today's situation all industries centered on the fine management of its method to urge optimized quality and energy saving to urge a lot of profit and client satisfaction. Completely different |in several |in numerous} industries the necessity and application of the motors are different. Here we tend to are talking a few drive which might save energy in addition as run motor on a variable speed to urge management over the method [1,2]. However allow us to point out the standard ways.

II. TYPICAL TECHNIQUE

In typical technique as shown in Fig: one. The electrical offer is given to rotate motor and thus machine or instrumentality. There's no management on speed of motor. Thus method is being controlled by mechanical systems like dampers, valves etc.

• We tend to are exploitation a lot of energy than needed &
• No precise management over the method.

So, for obtaining management on speed and saving energy we are going to point out instrumentality referred to as variable frequency drive (VFD).

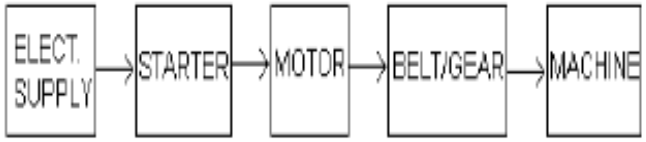

Fig: I - typical drive

III. WHAT'S VFD?

A variable-frequency drive (VFD) may be a system for dominant the move speed of Associate in Nursing AC (AC) motor by dominant the frequency of the electric power provided to the motor. A variable frequency drive may be a specific variety of adjustable-speed drive. Variable-frequency drives also are called adjustable-frequency drives (AFD), variable-speed drives (VSD), AC drives, small drives or electrical converter drives. Since the voltage is varied together with frequency, these are generally conjointly referred to as VVVF (variable voltage variable frequency) drives.

IV. VARIABLE FREQUENCY DRIVE

As shown in Fig: two electrical offers are given to the ability device that converts ac to dc. Then as per the method demand signal is generated by the controller for shift device to urge variable dc output that is once more reborn in to the ac and given to the motor[3]. The motor rotates at the specified speed and force. Thus, method is controlled by the motor effectively and energy will be saved.

V. IN OPERATION PRINCIPLE OF VFD

The synchronous speed of Associate in Nursing AC motor is decided by the frequency of the AC offer and the number of poles within the stator coil winding, per the relation:

$$RPM = 120 * f/p$$

Where, RPM = Revolutions per minute of motor
f = AC power frequency (hertz),p = variety of poles (an even number) RPM will solely be modified by ever-changing frequency of the availability or by ever-changing no. of poles of motor. Synchronous motors operate at the synchronous

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speed determined by the higher than equation[4,5]. The speed of Associate in nursing induction motor is slightly but the synchronous speed.

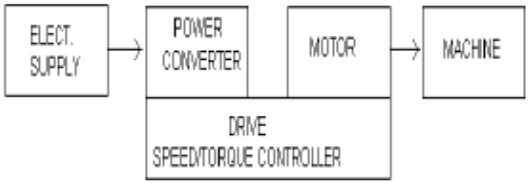

Fig: II Variable Frequency Drive

VI. FORCE DEVELOPING CHARACTERISTICS OF MOTOR

As we know, force is proportional to flux and rotor current.
$T \propto \phi * I$ And, Flux is proportional to V/f quantitative relation. $f_{\phi} \propto V_{\phi}$ $IT \propto V$ *
Where, ϕ =flux, V = offer voltage, I = rotor current, f = offer frequency.
To maintain force manufacturing capability of motor, we want to stay flux constant. thus to urge variable speed in addition as maintaining force manufacturing capability of motor we want to vary the voltage within the same proportion as frequency. Fig: three shows force developing characteristics of a motor. The potential unit per hertz quantitative relation (V/Hz) we are able to modification this quantitative relation to alter motor force. An induction motor connected to a 440 v fifty rate supply incorporates a quantitative relation of 8.8. As long as quantitative relation is maintained constant, Drive provides totally different |completely different} frequency output and thus different speed of the drive[6].

VII. EXPECTATIONS FROM THE DRIVE

• Variable speed at the motor shaft maintaining force manufacturing capabilities of the motor.
• Speed regulation
• Controlled acceleration and fastness
• Fast and safe reversal and breaking.
• Current limiting
• Protection against abnormal conditions
• Motor car improvement
• Simple fault nosology
• Communication capability
• Energy saving.
• Communication capability
• Energy saving.

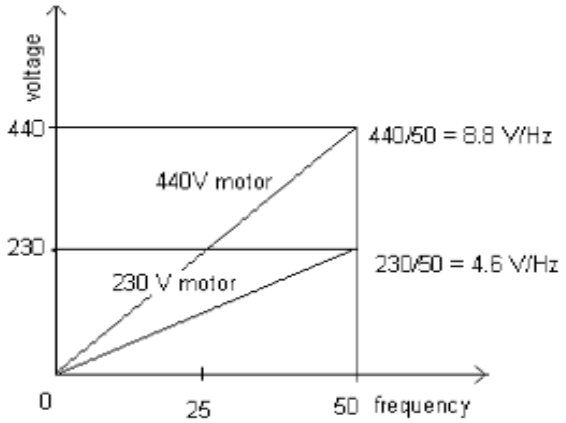

Fig: III force developing characteristics of Induction Motor

VIII. KINDS OF VFD

All VFDs use their output devices (IGBTs, transistors, thyristors) solely as switches, turning them solely on or off. Making an attempt to use a linear device like semiconductor unit in its linear mode would be impractical, since power dissipated within the output devices would be concerning the maximum amount as power delivered to the load [7].
Drives are classified as: Constant voltage, Constant current, Cycloconverter.
In a constant voltage device, the intermediate DC link voltage remains close to constant during every output cycle. In constant current drives, an outsized inductance is placed between the input rectifiers and also the output bridge, therefore the current delivered is almost constant [8]. A cycloconverter has no input rectifier or DC link and instead connects every output terminal to the acceptable input section.
The foremost common variety of VF drive is that the constant-voltage sort, exploitation pulse dimension modulation (PWM) to regulate each the frequency and effective voltage applied to the motor load. Pulse-width modulation (PWM) of an indication or power supply involves the modulation of its duty cycle, to either convey data over a communications channel or management the number of power sent to a load.

IX. VFD SYSTEM

As shown in Fig: four, a variable frequency drive system typically consists of Associate in Nursing AC motor, a controller Associate in Nursingd an operator interface.

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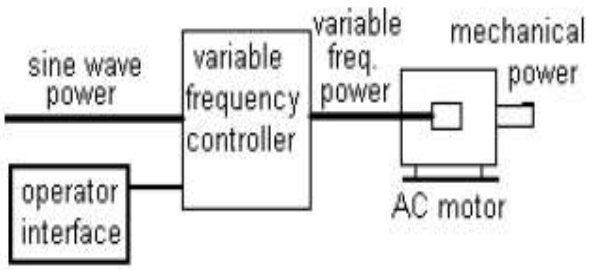

Fig: IV VFD Systems

A. VFD motor

The motor employed in a VFD system is typically a three-phase induction motor. Some kinds of single phase motors is used, however three-phase motors are typically most well-liked. Numerous kinds of synchronous motors provide benefits in some things; however induction motors are appropriate for many functions and are typically the foremost economical selection. Motors that are designed for fixed-speed and mains voltage operation are usually used; however bound enhancements to the quality motor styles provide higher reliableness and higher VFD performance.

B. VFD controller

As shown in Fig: five, variable frequency drive controller is solid state electronic power conversion devices. The standard style 1st converts AC input power to DC intermediate power employing a rectifier bridge. The DC intermediate power is then reborn to quasi-sinusoidal AC power exploitation Associate in nursing inverter shift circuit. The rectifier is typically a three-phase diode bridge; however controlled rectifier circuits also are used. Since incoming power is reborn to DC, several units can settle for single section in addition as three-phase input power (acting as a section device in addition as a speed controller); but the unit should be derated once exploitation single section input as solely a part of the rectifier bridge is carrying the connected load.

As new kinds of semiconductor switches are introduced, these have promptly been applied to electrical converter circuits in the slightest degree voltage and current ratings that appropriate devices are obtainable. The insulated-gate bipolar semiconductor unit (IGBT) is that the device employed in most VFD electrical converter circuits within the 1st decade of the twenty first century. AC motor characteristics need the applied voltage to be proportionately adjusted whenever the frequency is modified so as to deliver the rated force, for optimum performance, some any voltage adjustment is also necessary, however nominally constant volts per hertz is that the general rule. This quantitative relation is modified so as to alter the force delivered by the motor [8].

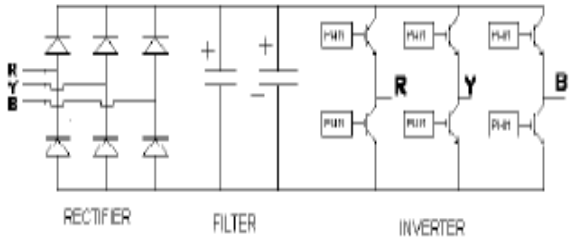

Fig: V PWM VFD Diagram

The usual technique used for adjusting the motor voltage is pulse-width modulation (PWM). With PWM voltage management, the electrical converter switches are accustomed divide the quasi-sinusoidal output wave shape into a series of slender voltage pulses and modulate the dimension of the pulses.

Operation at higher than synchronous speed is feasible, however is restricted to conditions that don't need a lot of power than plate rating of the motor.

This can be generally referred to as "field weakening" and, for AC motors, is working at but rated volts/hertz and higher than synchronous speed.

Example, A 100 hp, 460 V, 60 Hz, 1775 rev (4 pole) motor equipped 460 V, 75 Hz (6.134 V/Hz), would be restricted to 60/75 = 18 force at a 125 speed (2218.75 RPM) = 100 percent power.

An embedded micro chip governs the general operation of the VFD controller. The main microprocessor programming is in code that's inaccessible to the VFD user. However, some degree of configuration programming and parameter adjustment is typically provided in order that the user will customise the VFD controller to suit specific motor and driven instrumentality necessities [9].

C. Characteristics of PWM wave kind

- Voltage attending to the electrical converter is sliced rectangular form.
- Pulse dimension is variable
- PWM voltage is of high frequency sliced pulses.
- • owing to motor inductance the present flowing through winding are of curved nature.

D .VFD operator interface

The operator interface provides a method for Associate in nursing operator to start out and stop the motor and modify the Operating speed.

Further operator management functions may embody reversing Associate in Nursingd shift between manual speed adjustment and automatic management from an external method management signal. The operator interface usually includes Associate in Nursing digital display and/or indication

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lights and meters to produce data concerning the operation of the drive. Associate in nursing operator interface keyboard and show unit is usually provided on the front of the VFD controller. A serial communications port is additionally usually obtainable to permit

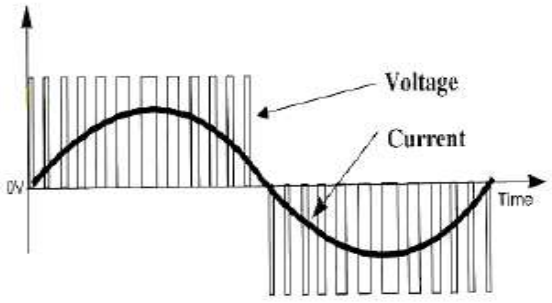

Fig: VI PWM VFD Output Voltage wave shape the VFD to be designed, adjusted, monitored and controlled employing a pc.

X. VFD OPERATION

When a VFD starts a motor, it at first applies an occasional frequency and voltage to the motor. The beginning frequency is usually two rates or less. Beginning at such an occasional frequency avoids the high in pouring current that happens once a motor is started by merely applying the utility (mains) voltage by turning on a switch. Once a VFD starts, the applied frequency and voltage are redoubled at a controlled rate or ramped up to accelerate the load while not drawing excessive current. This beginning technique generally permits a motor to develop one hundred and fiftieth of its rated force whereas drawing solely five hundredth of its rated current. Once a motor is just switched on at full voltage, it initially attracts a minimum of three hundredth of its rated current whereas manufacturing but five hundredth of its rated force. Because the load accelerates, the obtainable force typically drops a trifle then rises to a peak whereas the present remains terribly high till the motor approaches full speed[10,11]. A VFD is adjusted to supply a gradual one hundred and fiftieth beginning force from standstill right up to full speed whereas drawing solely five hundredth current. With a VFD, the stopping sequence is simply the opposite to the beginning sequence. The frequency and voltage applied to the motor are ramped down at a controlled rate. Once the frequency approaches zero, the motor is shut off. A little quantity of braking force is offered to assist decelerate the load a trifle quicker than it'd stop if the motor were merely transitioned and allowed to coast. Further braking force is obtained by adding a braking circuit to dissipate the braking energy or come it to the ability supply.

XI. APPLICATIONS OF VFD

Variable frequency drives are used for 2 main reasons:

1. To permit correct and continuous method management over a large vary of speeds.
2. To enhance the potency of the motor driven instrumentality by matching speed to changing load necessities.

XII. BENEFITS OF VFD

1. Variable speed at the motor shaft maintaining force manufacturing capabilities of the motor. 2. Controlled acceleration and fastness 3. fast and safe reversal and breaking. 4. Current limiting 5. Protection against abnormal conditions 6. Motor car improvement 7. Simple fault nosology 8.Communication capability 9. Energy saving.

XIII. DISADVANTAGES OF VFD

1. Initial price is high.
2. Needed skilful man power for operation and maintenance of VFD.
3. Harmonics in grid redoubled owing to frequent shift of power natural philosophy devices.

XIV. CONCLUSION

From higher than paper we are able to conclude that variable frequency drive may be a user friendly drive that saves energy and provides precise speed and force management of the motor.

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