# Inverter Duty Motors

An Online Continuing Education Course for Engineers

**Course Number: E-1007**

**Credit: 1 Hour / 1 PDH / 1 CPD**

# Inverter Duty Motors

**Rajendra Panwar, P.E.**

## Overview

This short course provides general but pertinent information on inverter duty motor. This course is intended for engineers in general and can be helpful for electrical engineers as well. It provides general information about inverter duty motor and related aspects. This information may be most suitable for engineers who want to become familiar with or intend to make use of variable frequency drive or inverter duty motor.

The information gained from this course will help an engineer apply the right approach and avoid equipment mismatch. The information is presented in concise and general terms that most engineers are expected to be familiar with. Technical details or mathematical formulas are avoided so that the ideas are covered in a simple manner. This course is not to be considered as comprehensive and is intended to be a refresher or introductory course.

## Definitions

**Horsepower:** Measure of power or rate of work done. Work done at the rate of 33,000 foot pounds per minute is defined as one horse power or HP. One HP = 746 watts.

**Voltage:** Volt, short for voltage is the unit measure of electric pressure. The pressure that will cause a current flow of one ampere through a one-ohm resistor is called one Volt.

**Frequency:** The number of periods or cycles an event is repeated in a particular time period is defined as Frequency, such as in the flow of electricity. For alternating current, the number of complete cycles in a second from zero to positive maximum, then to zero and then negative maximum and then to zero, is called frequency per second. Example: Utility Power Frequency is 60 Hertz or 60 cycles per second in US.

**Harmonics:** Utility Power has sine wave power at 60 Hertz in US. Power generated from DC using inverters creates square waves due to switching. This square wave power inherently has harmonics of the fundamental frequency. Normally present are 3, 5 and 7th harmonics in good strength. Higher harmonics are very weak.

## What is Inverter Duty Motor?

Standard AC induction motors, because of their simple design and construction, are more reliable and cheaper than DC motors. For this reason, they are very popular. However, with standard on line starter their use is limited to fixed speed application even though the process can be run over a speed range. This is a trade off made for low cost.

There are applications where, at times, the process can be run at lower speeds. In doing so, peak demand can be reduced and electric bills reduced by the energy savings. For such variable speed applications, a VFD or Variable Frequency Drive, also known as Variable Speed Drive, is needed. Their cost is more than standard direct online starters; but energy savings over time can eventually pay off the higher initial capital cost.

Now comes the question of using the standard speed motor with the VFD. Most regular AC induction motors are designed for use at one speed. A standard induction motor when run at reduced speeds may have inadequate cooling by the motor fan. Over longer periods, the motor may get overheated and ultimately fail. In addition, VFD output power to the motor inherently has power frequency harmonics. These harmonics are likely to present higher voltages at the motor winding for which they are not designed to withstand with the result being failure of the motor winding.

An AC induction motor that is specially designed for use with variable frequency drives is commonly known as an inverter duty motor. This motor has windings that can withstand harmonics and higher voltages and is also designed with proper cooling to run at lower speeds.

Different VFD manufacturers have different VFD designs. It may be prudent to buy the inverter duty motor along with the VFD as a package for the application and install them per vendor recommendations.

## Why an Inverter Duty Motor is Needed.

A regular AC induction motor can be used with a variable frequency drive. It is not uncommon for a user to couple a VFD to an existing regular AC induction motor. The variable frequency drive imposes the characteristics of its output power onto the motor. The existing regular motor is designed for common sine wave utility power. When the motor is subjected to the harmonics present in the variable frequency drive output, its life is shortened due to premature insulation failure.

There are specific applications that can run at varying speeds. A cooling tower fan is a good example. In winter when less cooling is needed, the fan can be run at a lower speed. Consider the two options below:

Option 1: We can use a standard induction motor with direct online starter, but the fan will run at one fixed speed only.

Option 2: A variable frequency drive combined with an inverter duty AC induction motor can be used very effectively and efficiently. Such installations can save energy at lower speeds. Energy savings over a period of time can pay back the extra cost of the variable frequency drive and inverter duty motor relative to the standard motor and motor starter.

Additionally, a properly selected inverter duty motor and variable frequency drive is likely to provide many years of reliable operation.

In applications where th e of an inverter duty motor and variable frequer where the energy costs are particularly high, the ty motor and variable frequency drive com ed to make use of such combinations for thei



## Inverter duty mo

A particular variable fr d requirements such as speed range, speed accu l types of variable frequency drives are co

Thus, it is important tha ve should match with each other to meet the ap kely to provide a nice package for the appl duty motors are available in various desig owing are some examples of inverter duty motor designs. Pleas ection for the areas where hazardous gases may be present, is normally dependent on the hazard area classification for the area, application and evaluation of available vendor recommended motor design.

- TEFC: Totally enclosed fan cooled. This type of inverter duty motor is normally used in chemical plants where corrosive or moderately hazardous gases may occasionally be present.

- ODP: Open drip proof type of inverter duty motor is normally used outdoors in non-hazardous environment.

- TEBC: Totally enclosed blower cooled inverter duty motors are specially designed motors for wide speed range applications. In this design, separate blower is utilized to provide adequate motor cooling at lower speed range.

- TENV: Totally enclosed non-ventilated design inverter duty motor is commonly used in moderately hazardous areas.