A

PROJECT REPORT

ON

“Rewinding of 3-Phase Induction Motor”

Electrical 6th semester

Undertaken At

V.P.M.P. POLYTECHNIC

Submitted By:

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Submitted To:

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CANDIDATE'S DECLARATION

I declare that 6th Semester report entitled "Rewinding of 3-Phase Induction Motor" **is our own work conducted under the supervision of the guide Mr. S.N.KHALAS.**

I further declare that to the best of my knowledge the report for Electrical Branch 6th semester which has been submitted for the award of ELECTRICAL DEPARTMENT either in this or any other university without proper citation.

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CERTIFICATE

TO WHOM SO EVER IT MAY CONCERN

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department of Electrical dept. 6th semester, under the guidance and supervision of Mr. S.N.KHALAS for the award of Diploma in Electrical Branch of VPMP POLYTECHNIC. They were involved in Project during academic year 2023-2044.

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:: PREFACE::

"Knowledge and human power are synonymous" once said the great philosopher Francis bacon however , based on experience within today's global markets , he would probable say, " the ability to capture communicate , and leverage knowledge to solve problems Is human power" this raise the question how exactly one can best capture ,communicate ,and leverage knowledge ,especially within the world of system engineering.

The answer probably lies in the statement itself by communicating your ideas and devising ways and means to give shape to your plans into reality this require ling term planning and shrewd thinking, for it is the long term investments that will ultimately help you scale great heights.

6th semester Electrical branch allows a student to implement what he learned within the four walls of his classroom. it is here that the mettle of student is tested to find his suitability for the rigorous tasks assigned to him in the future. A future executive is born on the basis of hard work and dedication he shows during these periods of his training.

The report that we are submitting intends to highlight our versatility in sustaining the professional life and put to perspective the fact that are capable enough to deliver whenever a challenge is thrown to us with the report we intend to highlight our thinking about it industry in particular.

We believe in right earnest that this report will set precedence not only among our peers but also for those who will follows us in the near future into the it Electrical Industry.

ACKNOWLEDGMENT

I wish to express my immense gratitude to HOD of Electrical Engineering for his mercy, guidance and protection towards me for seeing me through the rigors of this work. I am greatly indebted to my guide Prof. S.N.Khalas Sir for his kind gesture and whose critics lead to the achievement of this work. My special appreciation goes to my loving parents my grandparent, my uncles and aunties, my brothers and sisters whose moral and financial support cannot be over emphasized. Also my sincere gratitude and special regards to my friends too many to mention whose encouragement also lead to the success of this work.

ABSTRACT

When a motor fails, the user must decide whether to repair or replace it. To make a proper decision, one must consider the cost of the repair, the availability of a replacement, the age of the motor, the electrical design required for the application, any special mechanical features, and the urgency of returning the failed motor to service. Placing the driven equipment back into service is frequently the highest priority, and users often make their decision based on this criterion alone. Plant managers tend to be less concerned if the rewound motor is less efficient when their operation's downtime is costing thousands.

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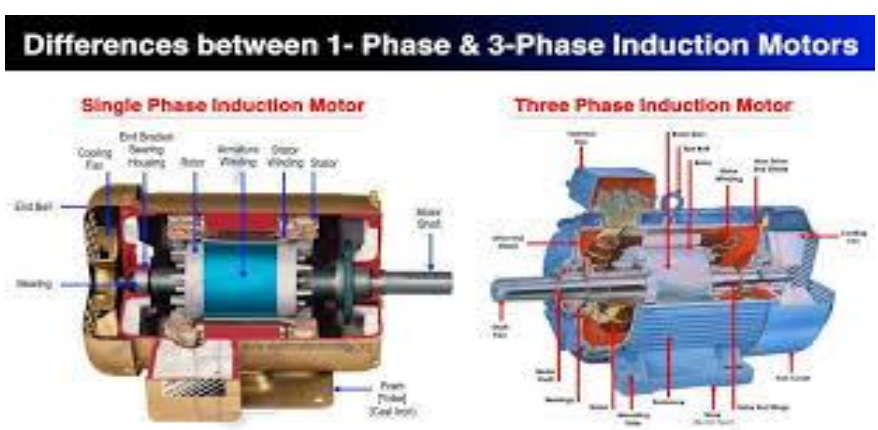
1. INTRODUCTION

AC induction Motors are everywhere, from household appliances such as water pumps and refrigerators to industry equipment such conveyor belts, right through to pumps on Navy warships. AC induction motors are electric motors which are driven by an alternating current (AC) as opposed to a direct current that drives DC Motors.

An AC induction motor generally consists of two parts- an outside stationary housing, with the stator being made up from coils in the form electromagnets arranged on the outside of the motor. This is supplied with an alternating current to produce a rotating magnetic field. The second rotating magnetic field in made up of an inside rotor, solid metal axle, loop of wire, coil and squirrel cage constructed of metal bars and interconnections attached to the output shaft.

AC induction motors have the potential for a very long life, due to the fact they have no common wear parts such as brushes and commutators being fairly low maintenance, routine inspections are often neglected for AC induction motors.



If a motor does fail, companies may experience downtime on production - which can be costly. When faced with this problem, businesses must decide between repairing, rewinding or replacing their motor. In this work we are focusing on the rewinding of a 5kva three phase induction motor.

1.1 BACKGROUND OF THE PROJECT

An electric motor converts electrical energy into a mechanical energy which is then supplied to different types of loads. A.c. motors operate on an a.c. supply, and they are classified into synchronous, single phase and 3 phase induction, and special purpose motors. Out of all types, 3 phase induction motors are most widely used for industrial applications mainly because they do not require a starting device.

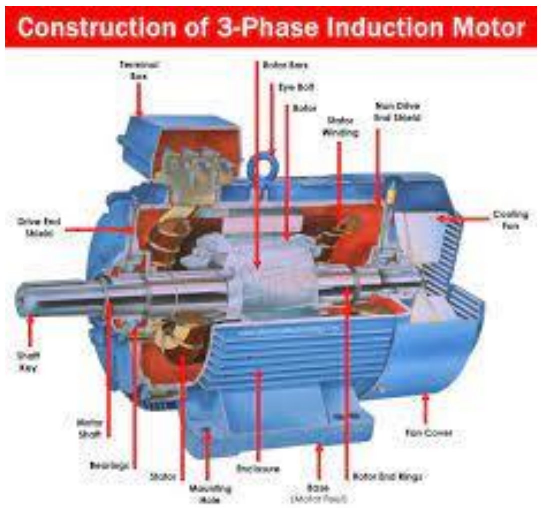
A 3 phase induction motor derives its name from the fact that the rotor current is induced by the magnetic field, instead of electrical connections. The operating principle of a 3 phase induction motor is based on the production electrical connections. The operating principle of a 3 phase induction motor is based on the production of r.m.f.

The stator of an induction motor consists of a number of overlapping windings offset by an electrical angle of 120°. When the primary winding or stator is connected to a three phase alternating current supply, it establishes a rotating magnetic field which rotates at a synchronous speed.

The direction of rotation of the motor depends on the phase sequence of supply lines, and the order in which these lines stator. Thus interchanging the connection of any two primary terminals to the supply will reverse the are connected to the direction of rotation. The number of poles and the frequency of the applied voltage determine the synchronous speed of rotation in the motor's stator. Motors are commonly configured to have 2, 4, 6 or 8 poles.

The synchronous speed, a term given to the speed at which the field produced by primary currents will rotate, is determined by the following expression. Synchronous speed of rotation = (120 supply frequency) / Number of poles on the stator

A rotating magnetic field in the stator is the first part of operation. To produce a torque and thus rotate, the rotors must be carrying some current. In induction motors, this current comes from the rotor conductors. The revolving magnetic field across the conductive bars of the rotor and induces an e.m.f. produced in the stator cuts The rotor windings in an induction motor are either closed through an external resistance or directly shorted. Therefore, the e.m.f induced in the rotor causes current to flow in a direction opposite to that of the revolving magnetic field in the stator, and leads to a twisting motion or torque in the rotor.



As a consequence, the rotor speed will not reach the synchronous speed of the r.m.f in the stator. If the speeds match, there would be no e.m.f. induced in the rotor, no current would be flowing, and therefore no torque would be generated. The difference between the stator (synchronous speed) and rotor speeds is called the slip.

The decision to rewind a motor or generatol begins with an assessment of its performance and condition. The tools include testing that combines electrical measurements, such as megger, polarization index, hi-pot, surge and partial discharge levels, with a comprehensive visual assessment. Repair specialists collect these results and take into account the required reliability the customer needs before making a recommendation.

1.2 AIM OF THE PROJECT

The aim of this project is to rewind a 5kw three phase induction motor from a burnt three phase induction.

1.3 OBJECTIVE OF THE PROJECT

At the end of this work student involved will:

1 Learn how to count number of turns of coil

Learn about mantling and dismantling of a burnt three phase induction motor.

2 Learn to count number turns of wire.

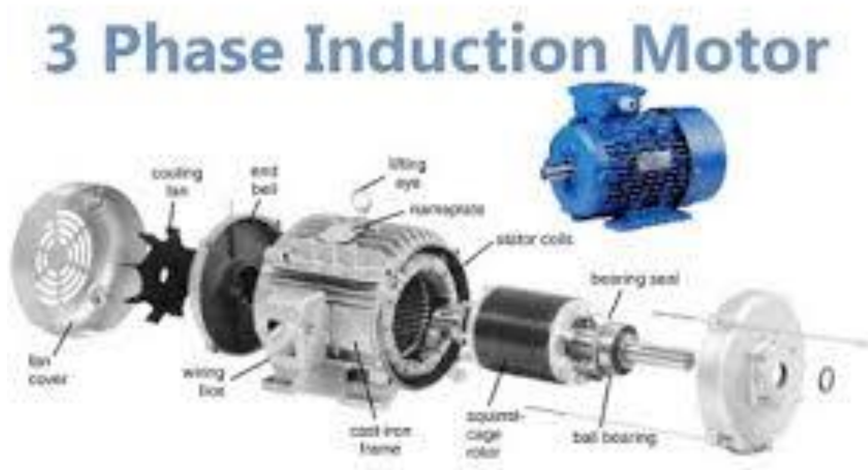
1.4 BENEFIT OF THE PROJECT

The importance of rewinding an induction motor is to reduce the cost of buying new motor, and in the course of rewinding the efficiency of the machine can be increased.

1.5 SCOPE OF THE PROJECT

The obvious best approach is to rewind the motor. If the magnetic core of a failed motor is undamaged and appropriate procedures are followed, a rewound motor will retain its original efficiency. Properly repaired, a "standard" efficiency motor will have its original "standard" efficiency, and an energy-efficient (EE) motor will have its original high efficiency.

On the other hand, those times when a motor has failed are also opportunities to upgrade motor efficiency. Especially if the failed motor is 10 or more years old perhaps with unknown efficiency, and possibly having been improperly rewound in the past - you will want to seriously consider all the options, and look into the economics of replacing it with a new motor.



1.6 PROBLEM OF THE PROJECT

The problem or issues noticed in this work is difficulty with the bearings, balancing, insulation, and rotor/stator refurbishing of the rewound motor.

The is difficulty with the bearings, balancing, insulation, and rotor/stator

1.7 CAUSES OF FAULTS IN ELECTRIC MOTORS AND THEIR EFFECTS

There are six main areas where faults occur due to a variety of reasons. These areas are usually referred to as fault zones and include the power circuit, power quality, stator, rotor, insulation and air gap. There are also different factors that can lead to failures in the electric motors. These are likely to affect the above fault zones in one way or another. The main causes include;

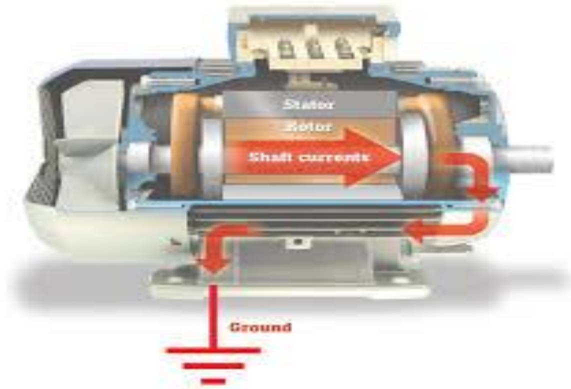
Low insulation resistance in Electric motors: Low insulation resistance is one of the most common causes of motor failures and also one of the most difficult to handle. A low insulation resistance leads to leakages or short circuits in the coils and finally the motor malfunction and failure.

When the insulation becomes weak, it eventually breaks down and does not provide the required isolation between the conductors or motor windings. The initial resistance of the insulation of the windings is usually very high - in the order over one thousand mega ohms (> IMO). However, after some time, the insulation starts degrading due to overheating or other undesirable conditions such as corrosion, physical damage and others conditions.

To prevent such problems, the maintenance people should perform regular inspections of the insulation.

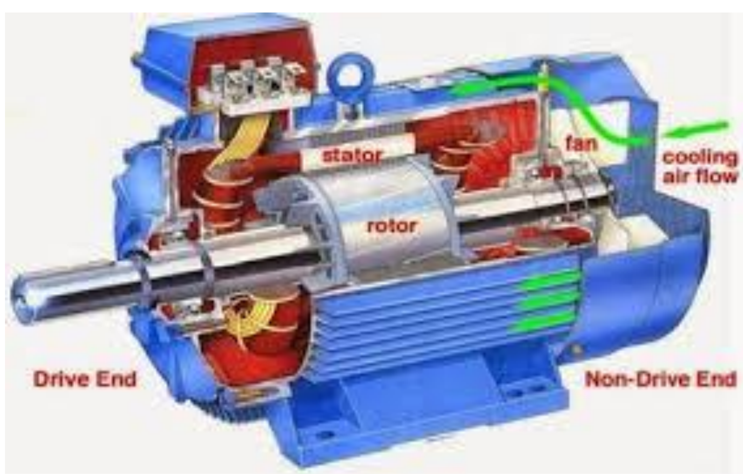
Electric motor faults due to over-Current: An electrical overload or over current condition occurs when excessive current flows inside the motor windings. This is usually more than the design current the motor winding can carry efficiently and safely. An over current may occur due to various reasons; in particular a low supply voltage will cause the motor to draw more current in an attempt to maintain its torque. Another reason is when there are short circuited conductors. excess voltage etc.

An overcurrent condition leads to overheating of the motor and damage to the insulation. And it is possible to minimize the risk of motor failures due to over current. This can be done by using reliable over current protection, to detect any over current condition, and interrupt the supply and hence stop the current.



Overheating problems in electric motors: Overheating in the motor occurs from a variety of reasons, the main one being bad power quality such as overvoltage or under voltage condition. If the supply voltage is higher that rated voltage, the excess voltage is dropped in the motor windings, resulting in to heat dissipation. On the other hand an under voltage will lead to over current condition which results into more 12R losses in the windings.

An over current condition may also hannen due to shorted windings or other conditions inside the motor



The other reason why overheating occurs in the motors is the overloading of the motor, or operating the in hot environments which are beyond the motor design or recommended temperature. A motor with excessive temperatures due power supply or operating environment will fail faster, especially if the rate of removing the heat away from the motor is low. Temperature will continue to increase as the heat generated remains in the motor, causing further increase in temperature and damage to the insulation. It is recommended to use ventilated areas, ventilation systems of cooling fans and if the environment is likely to get hot. An overheating condition existing for a prolonged period of time regardless of the cause will lead to insulation damage damage to the motor.

Vibration in

Electric motors: Vibrations can lead to several mechanical issues inside the motor and likely to happen is installed in an unstable surface.

when the motor addition, other faults in the motor such as loose bearings, misalignments, and corrosion related issues like wear may cause the motor to have internal vibrations. This reduces the accuracy and efficiency while accelerating the tear and wear the moving parts that are in contact with one another.

In on Moisture in AC electric motors: The moisture can cause a lot of problems to the motor by causing corrosion of various parts of the motor. In particular, the moisture will corrode the insulation, and lead short circuit between the windings, corrode the bearings, motor shaft and rotors.

This will prevent the smooth rotation, decrease efficiency and lead to fans, and lead to overheating. In addition, dust particles and other small objects inside the motor may introduce some complete failure Faults in of the motor. Electric motors due to dirt: Dirt such as dust and other debris can block the flow of air in the motor cooling resistance that will slow down the motor, meaning that it will have to work harder to overcome this resistance.

The dirt particles may also be abrasive in a way to damage the insulation.

2. Details Introduction of Induction Motor:

An induction motor or asynchronous motor is an AC electric motor in which the electric current in the rotor that produces torque is obtained by electromagnetic induction from the magnetic field of the stator winding.[1] An induction motor therefore needs no electrical connections to the rotor.[a] An induction motor's rotor can be either wound type or squirrel-cage type.

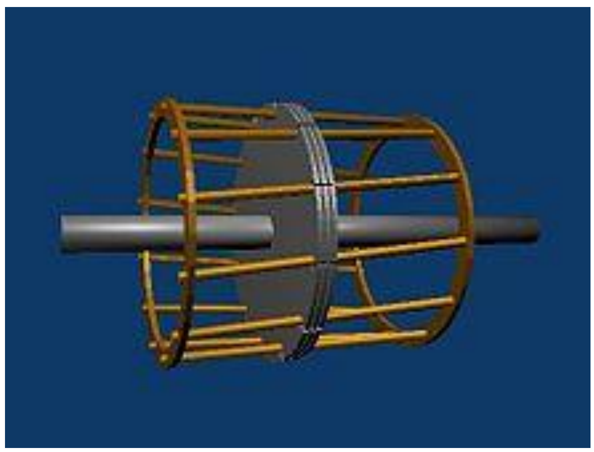
Three-phase squirrel-cage induction motors are widely used as industrial drives because they are self-starting, reliable, and economical. Single-phase induction motors are used extensively for smaller loads, such as garbage disposals and stationary power tools. Although traditionally used for constant-speed service, single- and three-phase induction motors are increasingly being installed in variable-speed applications using variable-frequency drives (VFD). VFD offers energy savings opportunities for induction motors in applications like fans, pumps, and compressors that have a variable load.

History

A model of Nikola Tesla's first induction motor at the Tesla Museum in Belgrade, Serbia

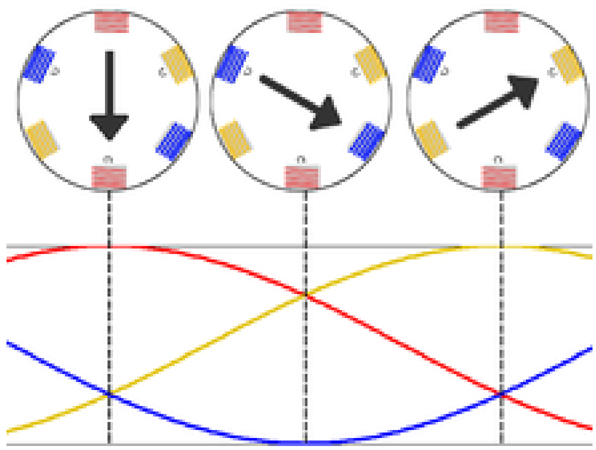
Squirrel-cage rotor construction, showing only the center three laminations

In 1824, the French physicist François Arago formulated the existence of rotating magnetic fields, termed Arago's rotations. By manually turning switches on and off, Walter Baily demonstrated this in 1879, effectively the first primitive induction motor.



The first commutator-free single-phase AC induction motor was invented by Hungarian engineer Ottó Bláthy; he used the single-phase motor to propel his invention, the electricity meter.

The first AC commutator-free polyphase induction motors were independently invented by Galileo Ferraris and Nikola Tesla, a working motor model having been demonstrated by the former in 1885 and by the latter in 1887. Tesla applied for US patents in October and November 1887 and was granted some of these patents in May 1888. In April 1888, the Royal Academy of Science of Turin published Ferraris's research on his AC polyphase motor detailing the foundations of motor operation.[5][11] In May 1888 Tesla presented the technical paper A New System for Alternating Current Motors and Transformers to the American Institute of Electrical Engineers (AIEE) describing three four-stator-pole motor types: one having a four-pole rotor forming a non-self-starting reluctance motor, another with a wound rotor forming a self-starting induction motor, and the third a true synchronous motor with a separately excited DC supply to the rotor winding.



George Westinghouse, who was developing an alternating current power system at that time, licensed Tesla's patents in 1888 and purchased a US patent option on Ferraris' induction motor concept. Tesla was also employed for one year as a consultant. Westinghouse employee C. F. Scott was assigned to assist Tesla and later took over development of the induction motor at Westinghouse. Steadfast in his promotion of three-phase development, Mikhail Dolivo-Dobrovolsky invented the cage-rotor induction motor in 1889 and the three-limb transformer in 1890. Furthermore, he claimed that Tesla's motor was not practical because of two-phase pulsations, which prompted him to persist in his three-phase work.

Although Westinghouse achieved its first practical induction motor in 1892 and developed a line of polyphase 60 hertz induction motors in 1893, these early Westinghouse motors were two-phase motors with wound rotors until B. G. Lamme developed a rotating bar winding rotor.

The General Electric Company (GE) began developing three-phase induction motors in 1891. By 1896, General Electric and Westinghouse signed a cross-licensing agreement for the bar-winding-rotor design, later called the squirrel-cage rotor. Arthur E. Kennelly was the first to bring out the full significance of complex numbers (using j to represent the square root of minus one) to designate the 90º rotation operator in analysis of AC problems. GE's Charles Proteus Steinmetz improved the application of AC complex quantities and developed an analytical model called the induction motor Steinmetz equivalent circuit.

Induction motor improvements flowing from these inventions and innovations were such that a modern 100-horsepower induction motor has the same mounting dimensions as a 7.5-horsepower motor in 1897.

3. Principle of induction motor:

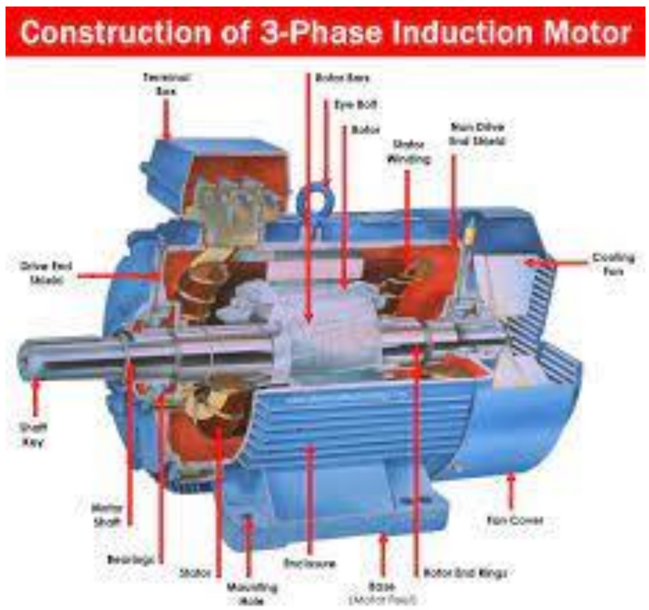
3-phase motor

An both induction and synchronous motors, the AC power supplied to the motor's stator creates a magnetic field that rotates in synchronism with the AC oscillations. Whereas a synchronous motor's rotor turns at the same rate as the stator field, an induction motor's rotor rotates at a somewhat slower speed than the stator field. The induction motor stator's magnetic field is therefore changing or rotating relative to the rotor. This induces an opposing current in the rotor, in effect the motor's secondary winding.[28] The rotating magnetic flux induces currents in the rotor windings,[29] in a manner similar to currents induced in a transformer's secondary winding(s).

The induced currents in the rotor windings in turn create magnetic fields in the rotor that react against the stator field. The direction of the rotor magnetic field opposes the change in current through the rotor windings, following Lenz's Law. The cause of induced current in the rotor windings is the rotating stator magnetic field, so to oppose the change in rotor-winding currents the rotor turns in the direction of the stator magnetic field. The rotor accelerates until the magnitude of induced rotor current and torque balances the load on the rotor. Since rotation at synchronous speed does not induce rotor current, an induction motor always operates slightly slower than synchronous speed. The difference, or "slip," between actual and synchronous speed varies from about 0.5% to 5.0% for standard Design B torque curve induction motors.

The induction motor's essential character is that torque is created solely by induction instead of the rotor being separately excited as in synchronous or DC machines or being self-magnetized as in permanent magnet motors.

For rotor currents to be induced, the speed of the physical rotor must be lower than that of the stator's rotating magnetic field otherwise the magnetic field would not be moving relative to the rotor conductors and no currents would be induced.



As the speed of the rotor drops below synchronous speed, the rotation rate of the magnetic field in the rotor increases, inducing more current in the windings and creating more torque. The ratio between the rotation rate of the magnetic field induced in the rotor and the rotation rate of the stator's rotating field is called "slip". Under load, the speed drops and the slip increases enough to create sufficient torque to turn the load. For this reason, induction motors are sometimes referred to as "asynchronous motors".

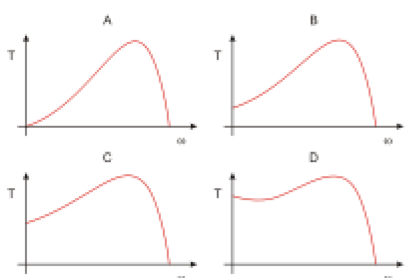
An induction motor can be used as an induction generator, or it can be unrolled to form a linear induction motor which can directly generate linear motion. The generating mode for induction motors is complicated by the need to excite the rotor, which begins with only residual magnetization. In some cases, that residual magnetization is enough to self-excite the motor under load.

Therefore, it is necessary to either snap the motor and connect it momentarily to a live grid or to add capacitors charged initially by residual magnetism and providing the required reactive power during operation. Similar is the operation of the induction motor in parallel with a synchronous motor serving as a power factor compensator. A feature in the generator mode in parallel to the grid is that the rotor speed is higher than in the driving mode.

Then active energy is being given to the grid.Another disadvantage of the induction motor generator is that it consumes a significant magnetizing current I0 = (20–35)%.

Slip:

S, is defined as the difference between synchronous speed and operating speed, at the same frequency, expressed in rpm, or in percentage or ratio of synchronous speed.



Torque:

Standard torque

Speed-torque curves for four induction motor types:

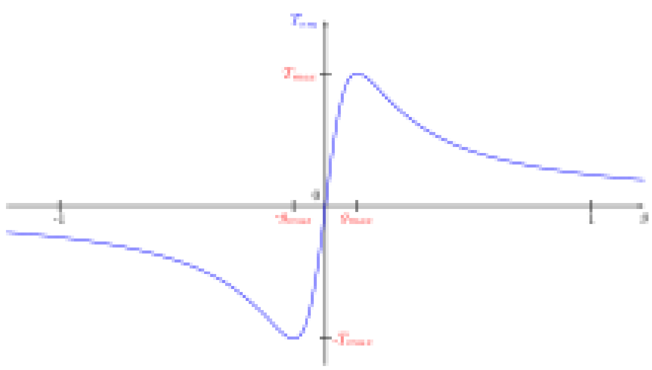
A) Single-phase, B) Polyphase cage, C) Polyphase cage deep bar, D) Polyphase double cage

Typical speed-torque curve for NEMA Design B Motor

Duration: 30 seconds.0:30

Transient solution for an AC induction motor from a complete stop to its operating point under a varying load

The typical speed-torque relationship of a standard NEMA Design B polyphase induction motor is as shown in the curve at right. Suitable for most low performance loads such as centrifugal pumps and fans, Design B motors are constrained by the following typical torque ranges:



Breakdown torque (peak torque), 175–300% of rated torque Locked-rotor torque (torque at 100% slip), 75–275% of rated torque Pull-up torque, 65–190% of rated torque. Over a motor's normal load range, the torque's slope is approximately linear or proportional to slip because the value of rotor resistance divided by slip,

Starting:

There are three basic types of small induction motors: split-phase single-phase, shaded-pole single-phase, and polyphase.

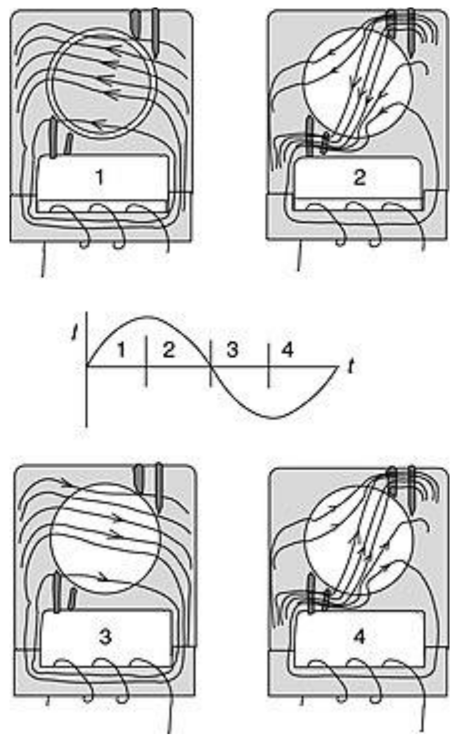
In two-pole single-phase motors, the torque goes to zero at 100% slip (zero speed), so these require alterations to the stator such as shaded-poles to provide starting torque. A single phase induction motor requires separate starting circuitry to provide a rotating field to the motor. The normal running windings within such a single-phase motor can cause the rotor to turn in either direction, so the starting circuit determines the operating direction.

Magnetic flux in shaded pole motor:

In certain smaller single-phase motors, starting is done by means of a copper wire turn around part of a pole; such a pole is referred to as a shaded pole. The current induced in this turn lags behind the supply current, creating a delayed magnetic field around the shaded part of the pole face. This imparts sufficient rotational field energy to start the motor. These motors are typically used in applications such as desk fans and record players, as the required starting torque is low, and the low efficiency is tolerable relative to the reduced cost of the motor and starting method compared to other AC motor designs.

Larger single phase motors are split-phase motors and have a second stator winding fed with out-of-phase current; such currents may be created by feeding the winding through a capacitor or having it receive different values of inductance and resistance from the main winding.

In capacitor-start designs, the second winding is disconnected once the motor is up to speed, usually either by a centrifugal switch acting on weights on the motor shaft or a thermistor which heats up and increases its resistance, reducing the current through the second winding to an insignificant level. The capacitor-run designs keep the second winding on when running, improving torque. A resistance start design uses a starter inserted in series with the startup winding, creating reactance.

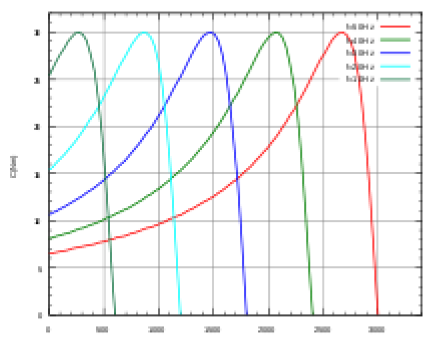


Self-starting polyphase induction motors produce torque even at standstill. Available squirrel-cage induction motor starting methods include direct-on-line starting, reduced-voltage reactor or auto-transformer starting, star-delta starting or, increasingly, new solid-state soft assemblies and, of course, variable frequency drives (VFDs).

Polyphase motors have rotor bars shaped to give different speed-torque characteristics. The current distribution within the rotor bars varies depending on the frequency of the induced current. At standstill, the rotor current is the same frequency as the stator current, and tends to travel at the outermost parts of the cage rotor bars (by skin effect). The different bar shapes can give usefully different speed-torque characteristics as well as some control over the inrush current at startup.

Although polyphase motors are inherently self-starting, their starting and pull-up torque design limits must be high enough to overcome actual load conditions.

In wound rotor motors, rotor circuit connection through slip rings to external resistances allows change of speed-torque characteristics for acceleration control and speed control purposes.



Speed control

Resistance

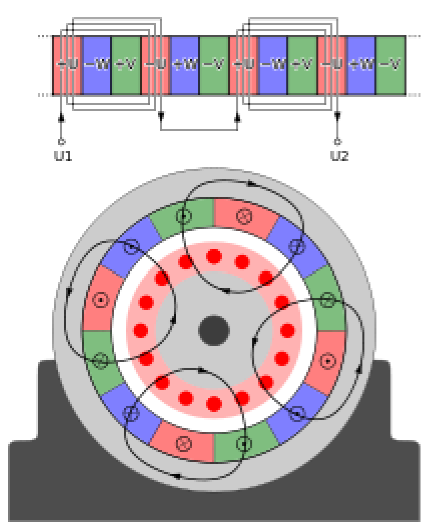
Typical speed-torque curves for different motor input frequencies as for example used with variable-frequency drives

Before the development of semiconductor power electronics, it was difficult to vary the frequency, and cage induction motors were mainly used in fixed speed applications. Applications such as electric overhead cranes used DC drives or wound rotor motors (WRIM) with slip rings for rotor circuit connection to variable external resistance allowing considerable range of speed control. However, resistor losses associated with low speed operation of WRIMs is a major cost disadvantage, especially for constant loads. Large slip ring motor drives, termed slip energy recovery systems, some still in use, recover energy from the rotor circuit, rectify it, and return it to the power system using a VFD.

Cascade

The speed of a pair of slip-ring motors can be controlled by a cascade connection, or concatenation. The rotor of one motor is connected to the stator of the other.[citation needed] If the two motors are also mechanically connected, they will run at half speed.

This system was once widely used in three-phase AC railway locomotives, such as FS Class E.333. By the turn of this century, however, such cascade-based electromechanical systems became much more efficiently and economically solved using power semiconductor elements solutions.



Variable-frequency drive

In many industrial variable-speed applications, DC and WRIM drives are being displaced by VFD-fed cage induction motors. The most common efficient way to control asynchronous motor speed of many loads is with VFDs. Barriers to adoption of VFDs due to cost and reliability considerations have been reduced considerably over the past three decades such that it is estimated that drive technology is adopted in as many as 30–40% of all newly installed motors.

Variable frequency drives implement the scalar or vector control of an induction motor.

With scalar control, only the magnitude and frequency of the supply voltage are controlled without phase control (absent feedback by rotor position). Scalar control is suitable for application where the load is constant.

Vector control allows independent control of the speed and torque of the motor, making it possible to maintain a constant rotation speed at varying load torque. But vector control is more expensive because of the cost of the sensor (not always) and the requirement for a more powerful controller.[43]

Construction

Typical winding pattern for a three-phase (U, W, V), four-pole motor. Note the interleaving of the pole windings and the resulting quadrupole field.

The stator of an induction motor consists of poles carrying supply current to induce a magnetic field that penetrates the rotor. To optimize the distribution of the magnetic field, windings are distributed in slots around the stator, with the magnetic field having the same number of north and south poles. Induction motors are most commonly run on single-phase or three-phase power, but two-phase motors exist; in theory, induction motors can have any number of phases.

Many single-phase motors having two windings can be viewed as two-phase motors, since a capacitor is used to generate a second power phase 90° from the single-phase supply and feeds it to the second motor winding. Single-phase motors require some mechanism to produce a rotating field on startup. Induction motors using a squirrel-cage rotor winding may have the rotor bars skewed slightly to smooth out torque in each revolution.

Standardized NEMA & IEC motor frame sizes throughout the industry result in interchangeable dimensions for shaft, foot mounting, general aspects as well as certain motor flange aspect. Since an open, drip proof (ODP) motor design allows a free air exchange from outside to the inner stator windings, this style of motor tends to be slightly more efficient because the windings are cooler. At a given power rating, lower speed requires a larger frame.

Rotation reversal:

The method of changing the direction of rotation of an induction motor depends on whether it is a three-phase or single-phase machine. A three-phase motor can be reversed by swapping any two of its phase connections. Motors required to change direction regularly (such as hoists) will have extra switching contacts in their controller to reverse rotation as needed.

A variable frequency drive nearly always permits reversal by electronically changing the phase sequence of voltage applied to the motor.

In a single-phase split-phase motor, reversal is achieved by reversing the connections of the starting winding. Some motors bring out the start winding connections to allow selection of rotation direction at installation. If the start winding is permanently connected within the motor, it is impractical to reverse the sense of rotation. Single-phase shaded-pole motors have a fixed rotation unless a second set of shading windings is provided.

Power factor

The power factor of induction motors varies with load, typically from about 0.85 or 0.90 at full load to as low as about 0.20 at no-load, due to stator and rotor leakage and magnetizing reactances. Power factor can be improved by connecting capacitors either on an individual motor basis or, by preference, on a common bus covering several motors.

For economic and other considerations, power systems are rarely power factor corrected to unity power factor.[46] Power capacitor application with harmonic currents requires power system analysis to avoid harmonic resonance between capacitors and transformer and circuit reactances. Common bus power factor correction is recommended to minimize resonant risk and to simplify power system analysis.

Efficiency

See also: Variable-frequency drive § Energy savings

Full-load motor efficiency ranges from 85–97%, with losses as follows:[48]

Friction and windage, 5–15%

Iron or core losses, 15–25%

Stator losses, 25–40%

Rotor losses, 15–25%

Stray load losses, 10–20%.

For an electric motor, the efficiency, represented by the Greek letter Eta,[49] is defined as the quotient of the mechanical output power and the electric input power.

Regulatory authorities in many countries have implemented legislation to encourage the manufacture and use of higher efficiency electric motors. Some legislation mandates the future use of premium-efficiency induction motors in certain equipment. For more information, see: Premium efficiency.

4. DESIRED QUALIFICATIONS FOR PROMOTER:

Any ITI electrician, Diploma or Graduate with engineering background and experience.

5. INDUSTRY OUTLOOK/ TREND

With large electricity grid and increasing power generation and distribution network in the country, population of electrical motors are increasing very rapidly in the country in rural, semi urban and urban centers. While urban centers have several large small and very small motor winding centers for repair and servicing centers for very small to large multi KW electric motors and generators.

6. MARKET POTENTIAL AND MARKETING ISSUES. IF ANY:

Just the pump industry is estimated that pumps sale alone is of the order of Rs. 3500 crores serving new and replacement needs. This it indicates motor rewinding market demand. Also there is need for very many centers in rural and semi urban centers in the country.

Irrigation water pump market is witnessing an impressive rate of growth on the back of depleting ground water level. These augers well for motor rewinding for newly electrified rural areas and villages. Domestic appliances and even pump sets have very good market potential as its demand emerges mostly from new and replacement needs of domestic users. In view of ever growing use of several new domestic appliances there is need rewinding and repair have good market potential in Govt. sector as well as in semi urban and rural sector.

There is new trend of use of automatic/ CNC winding / rewinding process. This is however suitable for large units having large volume likes new motor production units. However the rewinding unit with small investment has to use manual process.

7. RAW MATERIAL REQUIREMENTS:

The main raw material consists of electrical stamping and enameled / plastic insulated winding wires of copper in different gauges. Other mechanical repair activity may use parts like ball bearings or bushes of brass/ bronze, carbon brushes.

8. MANUFACTURING PROCESS:

The following items are main process steps:

- Dismantling motor body and removal of rotor assembly
- Checking the electrical circuit and electrical Stamping. In case of damage to enameled copper wire winding, the specific coil or complete is removed from the core slots by special scrapping tools and cutters.
- The new coil is wound with exact same gauge and insulation grade. The motor coil design is followed in terms of no of winding turns and lay in the core slot. The coils are checked for insulation, taped with insulation tapes/fillers and packed properly in the stator/rotor slots with wooden hammers followed by varnishing. The finished stator/ rotors are checked for insulation integrity.
- The stampings are checked and repaired or replaced partially as per original design.
- The bearing damage is assessed and repaired or replaced. The rotor shaft if damaged may be replaced.
- The motor is assembled with due care and free rotation and alignment of

rotor is checked. After mechanical checks, mugger test is carried out to see

the electrical integrity before powering and checking the speed in rpm.

Limited power rating is checked with load before dispatch to customer.

9. Apparatus & Components:

Following apparatus & components were used in completion of our project.

1. An aged capacitor-run single phase induction motor

2. 28 number (local) copper wire for winding

3. Forma to make winding with adjustable size

4. Special fiber paper for insulation

5. Cotton cloth for insulation

6. Basic tools for opening/dissemble the motor such as screwdrivers, hammers, wrenches, blades

7. Pen, pencil, clip, pins

8. Spray Lubricant such as varnishing materials (drying oils, resin).

10. Discussion:

1. The project was all about rewinding an aged motor to make it work and speeding up to the rated value. Although the main process was about winding, many facts came up according the working procedure of a capacitor-run single phase induction motor. First of all, the winding of the motor was a time consuming process but totally unpredictable of whether the project will be successful or not. The process was done under supervision of our course teacher and lab assistant teacher.

2. Due to the unavailability of a three phase induction motor of larger size and affordable price, the project was started with a capacitor-run single phase induction motor.

3. The study of the slot system and coil arrangement was learnt from an expert electrician from a local electric shop.

4. Before we got started with the rewinding process, we tried to run the motor by giving exact voltage connection from line voltage supply. But unfortunately the motor did not run which made it sure that the motor was quite an aged one.

5. The stator had 24 slots for winding. Eight slots were filled up with auxiliary winding and rest of them were filled up with main winding. The objective of auxiliary winding is to start up the device. But the motor can also start without help of the auxiliary winding. In that case, we needed to

start the motor by any external source. A capacitor was used in this motor. With the help of this capacitor the auxiliary winding started the motor.

6. In auxiliary winding, around 128-130 turns per coil were made whereas in main winding we took 155-160 turns per coil.

7. It was studied that if more wires are used in a single coils, the motor could carry out more load. On the other hand, if less coils are use, the motor could carry small load. Due to the complexity of inserting more wires in the slot gaps, we kept our number of turns in a single coil constant for all the windings.

8. During the making of coils by the help of a wooden forma from copper wires, it was tried to maintain same weight of before but the weight can be different a bit. Considering it negligible, we continued the winding process.

9. The coils (both of series and parallel connections) were placed with the stator slot properly by hand and sometimes with the help of pencil, pens, clips and pins.

10. The windings were closely attached with other coils, so it was necessary to insulate them from each other. So we used cotton clothes and sometimes special thread (provided by a electric shop) to bind them properly so that they don’t get shorted with each other, which could result into short connection and the motor might not run at all.

11. As our target was to get the rated value of speed, we needed to make sure to give input supply of rated voltage, which is why the motor was given connection with only 220V, never more or less voltage.

12. For the speed measurement of the motor’s shaft, different types of procedures were tried. But the unavailability of a tacometer (which can measure the speed accurately) and other exact equipment, we took the procedure of a software named ‘Audacity’, which could give us the maximum accurate wave-shape of the sound created by the rotor shaft.

13. The speed was measured to be 1463 rotation per minute which is quite greater than the rated value of speed. The rated speed was 1400 rpm. It is because when we measured the speed, the rotor was without any shaft load. If the shaft was loaded, we could get the rated speed value in our measurement. This explains the greater speed.

14. Therefore we can say, our prime motive of this project which was turning an aged motor into a running one by changing the windings of it, by rewinding it with new wires and getting the rated value of speed, was accomplished successfully with a little bit of error and mistakes in the winding process.

11. Complications:

The following complication were faced during the implementation and working on the project.

1. The space inside a slot was quite small and we had to put a whole coil inside it which needed quite effort and time. Moreover, the last number of turns were difficult to put through, so we sharpened a pen and pen-clips and pushed the coils inside which worked fortunately.

2. While using the 'forma' (the device to make coils of wires), sometimes the turns were being loosen. So we had to try more than once to make a single coil.

3. The number of turns were not exactly same in each coils. There might ±2 number of turns.

4. As the coils filled up all the spaces of the slots, it was hard enough to put insulations inside it.

5. It needed a lot of time and effort to cut the insulation papers in the right measurement.

12. 6th Sem Out Comes:

In the 6th Sem we are work on review of induction motor. And dismantles of induction motor.

13. Bibliography:

Link for study:

1. **file:///C:/Users/VPMP/Downloads/Project_Submission_Report_REWINDING_and.pdf**
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3. **https://old.amu.ac.in/emp/studym/2830.pdf**
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