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TITLE: MITIGATION OF PROBLEM IN THREE PHASE INDUCTION MOTOR FOR SPINNING APPLICATION

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Abstract

Induction motor are widely used as a main drive in textile industries. Our research paper suggests about efficient operation of three phase induction motor for energy conservation. For good quality spinning, it is essential that the starting torque of spinning motors should be moderate and the acceleration should be smooth. If the starting torque were low, the tension of the yarn would be insufficient and hence the yarn would get entangled and break. If the starting torque were high, the acceleration would be high and the yam would snap. The optimum spindle speed is the speed at which ring frame gives more output speed with less power input and keeping the prime mover under healthy condition. If the temperature of motor is increases, then the efficiency is decreases and to overcome this problem we use cooling fan on the surrounding of motor. higher efficiency motors (HEMs) are preferred than that of standard efficiency motors, because increased efficiency saves significant amount of energy consumed and therefore saves energy bill, costs incurred over maintenance of the standard motor. The losses are depending on the power factor. the power factor should be near about unity. If power factor is increases, then losses are decrease and efficiency is increase.

Index Terms: *Induction motor, textile, spinning, prime mover, power factor.*

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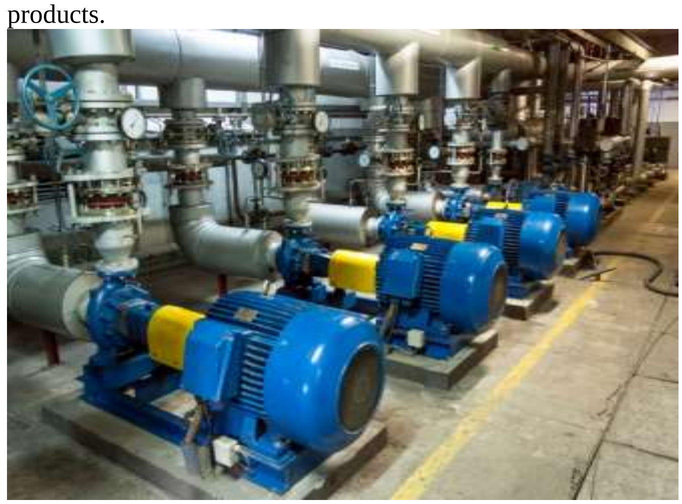
1. INTRODUCTION

Three phase induction motor are simple in construction, rugged, low cost and easy to maintain. Induction motor is a high efficiency electrical machine when working closed to its rated torque and speed. However, at light loads, no balance in between copper and iron losses, results considerable reduction in the efficiency. The part load efficiency and power factor can be improved by making the motor excitation adjustment in accordance with load and speed. They run at a constant speed from no load to full load.

In textile mill, they use group drive or a mix drive. So it is efficient and effective to control the drive with an AC supply than DC,and hence use three phase induction motor. Therefore, these motors are frequently used in textile industry. This motor is selected as driving power of spinning machine. Textiles are made from fibres, filaments, threads and yarn, either natural or synthetic. The textile industry grew out of the industrial revolution in the 18th Century as mass production of yarn and cloth became a mainstream industry. Textile Industry is a highly organized one with immense importance on capital intensive production process. This sector is characterized by sophisticated mills where technologically advanced machineries are utilized for mass production of textile products.



OBJECTIVE

In order to reduce the running cost of the motor with the typical high load cycles of industrial applications, higher efficiency is more important. We have therefore considered the maximization of motor efficiency as an objective function.

2. PROBLEM ARRISES IN THREE PHASE INDUCTION MOTOR:

2.1 Low voltage

Low voltage during a start can create an additional problem low voltage not the direct cause of motor overheating, due to this motor will not generate rated HP. The motor slip also increases proportionally to the square of the voltage drop. As a result, the motor will be running slower with a lower output voltage to determine this voltage one must take into account the total line drop to the motor terminals during the high current draw, which is present while the motor is starting. On designs which are subject to reduced voltage start and have a high risk of not properly starting, it is recommended that the voltage at the motor terminals be measured on the first couple of starts, after this motor or any other machinery is added to the power system, to eliminate concerns or problems in the future.

2.2 Overvoltage

It is normally true that motors tend to run cooler at rated horsepower at voltages exceeding rated voltage by up to 10%, but the current draw is only controlled by the load and at rated current and 10% overvoltage the motor will be overloaded by approximately 10%. The core loss is 20 to 30% greater than normal and could cause the machine to overheat. If it is verified that the motor will see an overvoltage, the overload current relay must be adjusted downward to compensate, or stator temperature detectors should be used to monitor the temperature.

2.3 Voltage unbalance

A symmetrical three phase supply system has three identical phases with the voltage of each phase and line equal in magnitude and displaced from each other by 120°, but as a result of a number of possible factors, the terminal voltage at the load end is often unbalanced. According to, “in a 3- phase supply system, voltage unbalance condition is when the phase or line voltage magnitudes are not the same and the phase angles of each phase varies from the balanced voltage conditions, or both.” Experiences in the electrical field as revealed that unequal sharing of single phase loads among the three supply phases, which may also frequently vary is one of the major causes of unbalance. Machines are designed to operate at balanced rated voltage level, and according to “all induction motors have some inherent phase unbalance due primarily to mass production tolerances” such that these four conditions often play out during motor operation, these are

- Rated Voltage Operation
- Balanced Over-voltage Supply Condition
- Balanced Under-voltage Supply Condition
- Unbalance Voltage Supply Condition

2.4 Difficulties in starting

The difficulties in a starting of motor are arises in a textile industry for spinning application has been solves by the below steps:

If the voltage is low, the cause of the low voltage should be located. it does not take much of a voltage increase to eliminate the problem since torque varies as the square of the voltage. In addition, the motor manufacturer may allow a longer acceleration time at this lower voltage since the heating in the motor is a function of the I^2T and the current is proportional to the voltage.

Input Ratings	Power Supply Allowable Variation	3 Phase, 415v, 50Hz Voltage: +/- 5% Frequency: +/- 5% Imbalance in power supply 3% Or Less
Output Ratings	Output Voltage Output Frequency Overload Capacity	3 Phase, 415V 50 Hz 150% of rated current for 1min.
Control Specification	Control System Freq. Control Range Torque boost Accel./Decel./time	Sinusoidal Wave PWM 2 to 240 Hz 16 selectable modes 0.1 to 200 Sec (Independently adjustable)

Table 1: rating of three phase induction motor

3. PARAMETER OF THREE PHASE INDUCTION MOTOR:

3.1 Efficiency

Maximum efficiency in the induction motor is achieved when the rotor is turning almost as fast as the magnetic field in the stator - a slip close to zero. But in order to deliver increased torque for higher loads, a higher slip may be preferred as depicted in the diagram below. Optimized slip control uses algorithms to find the ideal balance at any point in time for either max efficiency or max torque.

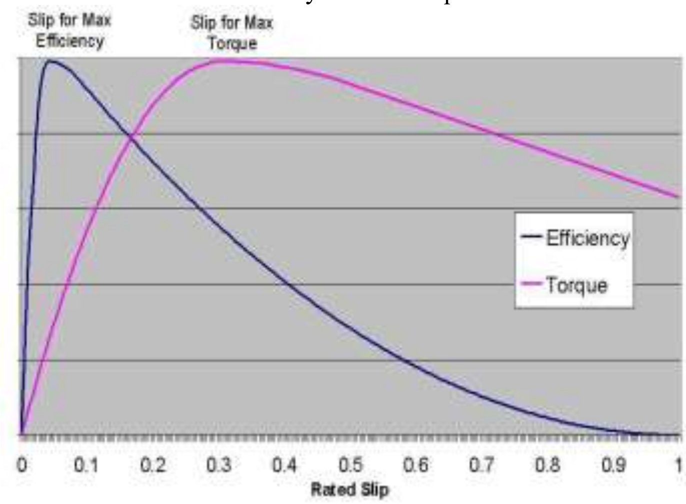


Figure 1: efficiency/slip and torque characteristic

Efficiency Improvement

The efficiency of the motor is increased by using multi-strand with multi-turn coils in the stator winding. Multi-strand with multi turn coils will increase the surface area of the conductors in a slot. This increases the active material present in the stator winding resulting in increase of efficiency. The reduction in the stator resistance is explained by the following equations: The resistance of stator winding with single strand with multi turn coil,

$$R = \varrho\, l/A$$

Where,
R= Resistance of the stator winding.
ϱ =Resistivity of the winding
l=Length of the winding
Stator copper loss = $I^2R = I^2 \varrho\, l/A$
Resistance of the winding with multi-strand with multi-turn coil with X number of strands per turn.

$$R = l\, \varrho / XA$$

Stator copper loss = $I^2R = I^2 l\, \varrho / XA$,
Where X=1, 2, 3 ...N
Therefore, with increase in number of strands in a turn, the area of the coil increases, hence stator resistance decreases to a considerable extent. . (The inductance value is same as the existing motor)

3.2 Temperature of motor:

Size of any motor, depends on the Temperature rise in the machine. Temperature rise in the electrical machine beyond the designed value will damage the insulation of the motor. Temperature rise in the electrical machine is due to the heat generated due to losses. Current flowing in the windings in the machine generates heat. This generated heat should be dissipated else it damages the insulation of the motor. The size or dimension of an electrical motor depends upon the speed of an AC electric motor.
For smaller rating motors, natural cooling is sufficient. However for larger rating motor heat generated will be more, hence generated heat should be removed with the help of coolants such as water either by natural circulation or forced circulation. Fans and blowers were also used to remove the generated heat.

3.3 Size of Motor:

The total flux around the armature (or stator of an AC electric motor) periphery at the air gap is called the total magnetic loading. While total electric loading is the total number of ampere conductors around the armature (or stator of an AC electric motor) periphery. Since the output coefficient of an AC electric motor is proportional to the product of specific magnetic and specific electric loading of an AC electric motor, we conclude that the size and hence the cost of AC electric motor decreases if increased values of specific magnetic and electric loading are used. Electric motor decreases if increased values of specific magnetic and electric loading are used.
Increase in motor speed (ns)
Increase in magnetics/magnetic loading (br)
Motor output power:

$$P_{out} = KBavacD^2LNs$$

Where,
Pout = Output power (W)
K = Constant
Bav = Average air gap flux density (T)
Ac = Electrical loading (amp – turn/m)
D = Rotor diameter (m), L= Length of rotor (m)
Ns = Motor speed (rpm)
For the same output power, the size of the motor can be reduced by:
1. Increase in magnetics/magnetic loading (i.e. Increase in magnet Br and hence the Bav)
2. Increase in motor speed (Ns)
3. Increase in winding current or no. of turns/coil (i.e. Increase in ac)

Br(T)	0.41	0.69
Volume ratio	1.00	0.69
Total motor weight (g)	335	246

Table2: factor depending on size of motor

3.4 Power Factor:

Improving the PF can maximize current-carrying capacity, improve voltage to equipment, reduce power losses, and lower electric bills. The simplest way to improve power factor is to add PF correction capacitors to the electrical system. PF correction capacitors act as reactive current generators. They help offset the non-working power used by inductive loads, thereby improving the power factor. The interaction between PF capacitors and specialized equipment, such as variable speed drives, requires a well-designed system. A textile plant has major electrical load in the form of induction motors. Power factor of typical motor is in the range of 0.75 to 0.85 and the average of the selected load is 0.8. After installing capacitor, this power factor becomes 0.95. This analysis also shows that power factor improvement finds a great scope to save electrical energy by reducing the distribution losses.

$$\Phi = \cos^{-1}(pf)$$

Reduction in distribution loss=$(1-(pf1/pf2)^2)$x 100

Rated power (kw)	Power drawn(kw)	Present power factor	Target power factor	Improve power factor	Reduction in losses(%)
15	13	0.76	0.95	0.95	36
15	13.5	0.85	0.95	0.95	19.9
15	14	0.79	0.95	0.96	32.3
20	17	0.79	0.95	0.95	30.8
20	17.5	0.75	0.95	0.95	37.7
20	41	0.82	0.95	0.96	27.03

Table 3: power factor improvement

ADVANTAGES

1. Provides the smooth operation of the yarn winding in spinning mills and reduce the yarn breakages.

2. Longer service intervals

3. Reduce down time and higher productivity.

3. CONCLUSION

The efficiency of three phase induction motor is increases by improving the temperature. If we decrease the temperature, then efficiency is increases. Also the efficiency of the motor is increased by using multi-strand with multi-turn coils in the stator winding. Voltage unbalance leads to the generation of unusable negative sequence currents and torque which wastes energy and weakens insulation, and these negative effects even becomes greater as percentage unbalance exceeds the NEMA recommended 5% allowance limit.

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