OPTIMUM USE OF INDUCTION MOTORS IN TANZANIAN INDUSTRIES

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An electric motor is used to convert electrical energy to mechanical energy. The simplest in construction and the most widely used are the plain polyphase induction motors (about 80% of the world's a.c. motors).

Here in Tanzania, our industries use three-phase induction motors, ranging from a few kilowatts to about 100 kW, for most of its energy conversion requirements. Inspite of having a good design life of about 20 years, the motors usually do not live up to about a quarter of its life.

In a local textile factory, with about 2,000 installed looms, up to 5 motors burn daily, at times, making the production of textile quite expensive. In cotton ginneries, up to 10 motors burn per season. With a small, ill-equipped workshop, authorities have a hard time to serve about 20 ginneries in the country (1). With many examples from other industries like sisal, tea, coffee, etc., it is clear that motors have very little life here in the country.

1. Possible causes of motor failures

One possible reason for short life of the motors could be the inconsistency of the available line voltage and the rated line voltage of the motor. Thus, a motor rated for a line voltage of 380V are commonly imported while TANESCO normally supplies about 410V line voltage. This increment can cause a slow deterioration of the insulation, and the consequent increase of current could affect the winding wires.

Poor ventilation can cause the winding temperature rise beyond the permissible temperature. Hence, the life of the insulation decreases considerably. It is very often that motors are fully covered with dust while in operation; for example, in cotton ginneries and textiles, motors are covered with "cotton dust", while in sisal plants with sisal fibres, etc. This reduces the surface area through which the motor can dissipate heat. Hence, the surrounding of the motor should be clean with adequate ventilation provided. This can reduce the risk of of excess temperature rise of the windings.

Aligning a motor properly is also essential. Mis-alignment can cause abnormal load on the bearing unnecessary frictional losses increased. Likewise, proper mounting of the motors on site is essential for its efficient performance.

Quite often new mechanical modifications are made resulting in, at times, increased load for the motor. A tong ammeter can satisfactorily show the load on a motor and can be compared with the rated value of the current given on the name plate. Once an overload is detected, steps should be taken to investigate the cause of overload and find means to remove the overload or to replace the motor with a higher power rating.

The most common, and incidently the most dangerous practice in industries is to replace fuses with thick copper wires! When a motor is overloaded it trips-off, i.e. the fuses burn-out and protect the motor. The electrician, however, usually forces the matter using thick copper wires so that the tripping stops.

Motors are also protected by thermal tripping relays having various possible tripping currents. The setting of the proper tripping current depends on the starting method of the motor, whether it is direct-on-line or star-Delta.

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Example of an induction motor's stator winding

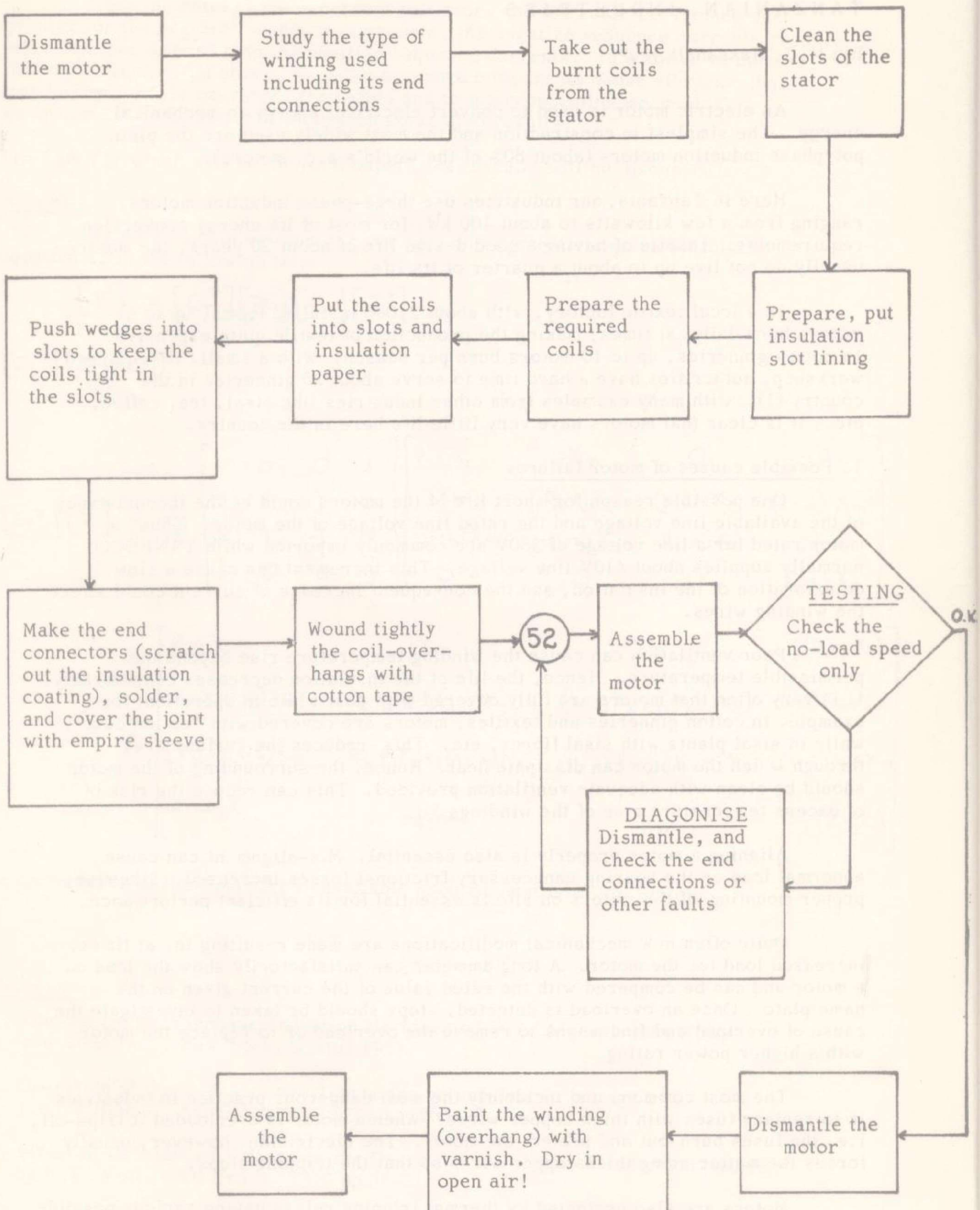

Figure 1: Flow Chart for Rewinding Motor normally practiced in Tanzanian rewinding Workshops

For Star-Delta Starting, the setting is about 3-4 times the rated current. When an overload trips-off the relay, the electrician would set the tripping relay at even 8 times the rated line current; and for cases where an overload is sustained, then the higher current increases the winding temperature and eventually the insulation breaks down. Both practice should be stopped immediately; checks should be made to find the cause of trippings.

Lastly, it should be known that most motors around are continuous rating, i.e. its operating period is indefinitely long so that the temperatures of all parts of the motor attain practically steady values at a constant ambient air temperature (not exceeding the limits specified by the IEC Standards). Overload or frequent start-stop operation can harm the motor, as during the start-stop operation can harm the motor, as during the starting the motor draws about 6-8 times its rated line current (although for about 6 seconds only). If the job conditions demand such a start-stop operation quite oten, then a motor dimensioned for a such an operation should be installed.

2. Present trends in rewinding

Once a motor is burnt, the industries normally send them to a private rewinder unless they have a workshop. The practice followed by the rewinders is to make an exact copy of the burnt windings using the scheme briefly outlined in Figure 1. This is done by persons having about 4 to 5 years of experience. This experience consists of 1 to 2 years as an apprentice whose main job is to remove the burnt winding and prepare coils; and 2 to 3 years of experience as a winder.

This method of repair is some sort of a trial and error one. Only a handful of the rewinders have any technical education and qualifications, resulting in a dependenc e on rewinder's individual ability to reproduce the copy of the windings. As a matter of fact, the person who studies the burnt winding makes no records and when he is transferred or is on leave or simply forgets the winding details, the motor becomes "unrepairable"! For this very reason,it is common to have a large amount of motors in a workshop unrepairable.

Another common practice is to have the needed winding wire, out of stock. It is possible that the winder then would choose, for some reasons, a wire with a diameter smaller than the required one. This increases the copper losses of the motor. By choosing a larger diameter instead, the copper losses are somehow reduced and also can withstand a bit larger rated line current.

The main cause of such tendencies in industry arises from the lack of skilled manpower to provide not only the technical advice but also efficient production management. The situation is worse in parastatal organisations where a small workshop is expected to serve many sections of the industry.

3. Possible Solutions

The present situation of having the economic life of motors been about a quarter of its design life causes a great concern as it increases our yearly depreciation costs. The motors are purchased using the hard-earned foreign exchange, and steps should be taken to limit the chances of having a poor economic life for motors.

3.1 Maintenance on Site

In order to improve the efficiency and the life of the induction motors, urgent steps should be taken in maintenance of the motor on site. Assuming that properly rated motors have been installed, adequate electrical protection and proper ventilation should be available at all times. Proper fuses and correct thermal tripping settings for the motors have already been emphasised. Likewise, the motor should have proper means of discipating heat - i.e. clean cooling surface and good ventilation. Other suggestions have been mentioned in section 1.

3.2 Documentation of the Winding dates:

Once a motor is burnt, proper documentation of the winding data should be made. A winding diagram should be prepared, number of turns, wire diameter and all other relevant winding data should be recorded. This ensures that a motor would not be left unwound, just becuase no winding data is available.

3.3 Modification should be recorded

Any modifications made in the winding, for whatever reason, should be recorded. For example, if the windings of the motor were made for 380 V line voltage, then the winder can advice the client that the voltage is inconsistent with the available line voltage, 410 V. With the consent of the client, the winder can make the winding of the motor during rewinding be suitable for 410V line voltage by adding a few more turns.

Another example mentioned earlier is the wire diameter if the required wire is not available, then the new wire diamerer must be recorded.

3.4 Fresh design of a "dead" motor

Most of the workshops around the country have many motors that are unrepairable (so called "dead" motors) and are somehow treated as scrap. These motors can be revived by designing afresh the windings using the available data and informations, and thus save the need of buying a new motor.

3.5 Optimization of Motors

While designing afresh, the output power of the motor can be optimized by making the maximum possible utilization of the stator slots. Furthermore, with the use of latest available class of insulation material, the optimized output power can also be achieved.

A research, in the form of Student's Project, has been done in the Department of Electrical Engineering of the Faculty to investigate the optimization of the output power of an induction motor. The findings of the research showed that the above mentioned ways of optimization actually yielded an extra load of 21% of the original rated output power (2). Using a stator frame of an induction motor rated at 2.2 kW, the research showed that the optimized output power using class B insulation material was 2.65 kW, with an efficiency of 0.76.

3.6 Manpower Requirements

The possible solutions mentioned above requires good technical know-how; for cases (1) and (2), any experienced electrician can follow up the suggested maintenance on site and recording of data. Therefore, such suggestions could be made aware to the concerned maintenance personnel.

However, for cases (3), (4) and (5), the basic requirement for our industries is the presence of a competent electrical engineer, who has much knowledge and design experience in the field of electrical machines. He should be backed by a well-equipped laboratory and workshop with adequate skilled manpower. With the availability of other requirements (like, for example, data for stator-core material from the various manufacturers, etc), the design department can help the industries by

i) reviving the "dead" motors, at present quite many in the country,

ii) advice on the purchase of new motors, especially its type of service, service conditions like ambient temperature, hazard environments, etc., and,

iii) help to coordinate the necessary maintenance on the motors to reduce the chances of breakdowns. In such cases, emphasis on a clean external cooling surface and proper electrical protection could be made.

4. Conclusion

To establish such a department, the initial costs will seem to be high. However, we have many authorities like Tanzania Tea Authority, Tanzania Textile Trading Company Ltd., Tanzania Cotton Authority, Sugar Development Corporation, National Development Corporation, to mention a few, having many industries (or factories) requiring such workshops. The exhorbitant losses occuring yearly due to breakdowns result in high maintenance cost, large loss of production hours and manhours and loss of export sales. Therefore, it is up to these authorities to decide now whether a "central electrical machinery and drives workshop" should be planned to serve all their factories or smaller workshops in each factory. There is no doubt that either of the workshops will be of real economic value in the long-run, and shall bring about efficient production in local industries.

The awareness of properly designed motors for use in our local industries can further lead to a need of manufacture of electricla machines here in Tanzania, especially in the wake of the new Five-Year Development Plan that puts good emphasis on heavy industries.

References

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