ASSESSMENT OF AGRICULTURAL ELECTRIC MOTORS MAINTENANCE

M.S. PATWARDHAN, T.R.V. NAIDU,
Dr. A. S. College of Agricultural Engineering,
Mahatma Phule Krishi Vidyapeeth,Rahuri,
E mail patmam@sify.com

Abstract :

Agriculture is backbone of Indian economy. Energy requirement in agriculture varies widely according to cropping pattern farm activities and level of technology used in farming. Farmers are using electric motors for various applications in modern farming. To study problems associated with electric motors adopted by farmers survey has been carried out at Rahuri. The survey revealed that 77% motors used for irrigation purpose and 23% for drive purpose. About 80% farmers reported that there was no guidance for installation, selection and maintenance of pumping system. Failure of motor affects timely operation schedule like irrigation and more energy wastage takes place.

Keywords : Energy intensive farming, electric motor, maintenance.

Introduction

Agriculture is basically an energy conversion industry. A farm is an energy consumer and a producer, because with the use of the different energy inputs, energy output as a crop production is available. The level of energy used, cropping pattern and cropping intensity are the important issues related to crop production. In modern agriculture, the choice of energy resources has been dynamic due to chemical inputs and electrochemical power resources. Indian agriculture is lagging due to its low inputs – low output model (Reddy, et. al, 2001). However for getting better economic results farming must be considered as a business. By utilizing available land and water resources at optimized level intensive farming may be adopted. Traditional agriculture was mostly dependent on non – commercial energy sources while in modern agriculture, commercial energy sources like fuel, machinery and chemicals contribute bulk of the energy supplies to the production system (Koppad and Maurya, 1994). Modern agriculture is increasingly becoming highly energy intensive. It requires additional 6.88 GJ of energy for increased production of one ton of food grains (Anonymous, 2005). Specific energy consumption of Indian agriculture is higher than that of its competitors and it is on rising trend. The situation, therefore, demands a systematic study of energy efficiency. Farmers are adopting new technologies on farm to bring maximum area under irrigation by using electric motors. Today near about 59% area of total irrigated area is irrigated by means of lift irrigation (Anonymous, 2004).

For increasing demand of electric motor application for agricultural purpose, it is necessary to take care of motor during its operation for increasing its operating efficiency as well as economy. Hence electric motor maintenance is essential. The reliability of any machine results in good working capacity at any time. It is necessary to rectify defects quickly and taking timely action to avoid permanent faults in the motor. Thus maintenance is most essential.

This paper gives an account of electric motors from maintenance point of view and problems associated with the systems. The remedial measures are also suggested to improve the performance of electric motor. Ultimately it gives good energy management on farm.

Materials and Methods

Based on growth pattern of energy inputs and productivity, planning for resource allocation in terms of fertilizer, diesel, electricity and mechanical power can be done. Since the use of human and draft animal energy is declining, the additional ten times increase in requirement of electromechanical energy may have to be made for future projection. For intensive farming, non-commercial sources are not sufficient. Hence supplementation and substitution with commercial energies, assured supplies and better management are absolutely essential.

One of the major inputs adopted by the farmers for increasing land productivity is irrigation. The change in pattern of use of irrigation resources necessitated more reliance on irrigation pump sets. There has been a drastic increase in utilization of ground water since the sixties due to expanding rural electrification and large scale increase in use of energized pump sets. Diesel engines and electric motors are widely used by the farmers mainly for lifting irrigation water, apart from operating stationary farm machines like thresher and cutter. The population of these prime movers has increased tremendously since the green revolution.

The net area under irrigation has increased from 20.85 Mha (17.55% of cultivated area) in 1950 –51 to 53.14 Mha (38.61 % of cultivated area) in 1996 – 97 with annual growth of 2.13 % (Anonymous, 2005).

Maharashtra exhibited a steady reduction in diesel engine but increased electric motor population since 1971. It has been increased by 4% growth rate from 1971 to 1981. With availability of electricity, the growth rate increased to 4.58 % during next ten years with more than 26 thousand units being added each year to the population. The trend suggests that 1.28 million units would be available by 2005.

The power availability would be about 0.85 times of the national average. The total stationary power availability in the state increased from 0.13 kW/ha in 1971 to 0.21 kW/ha in 1995. It is expected to reach 0.29 kW/ha in 2005 as per the studies carried out. Electric motors would contribute 91% to the total power.

Thus to optimize energy sources used in agriculture it is necessary to concentrate on performance of electric motors used in agriculture. By doing proper maintenance efficiency of electric motor can be improved. To understand the problems in this regard a survey has been carried out. In this survey, total of 75 motors were studied in the Rahuri and Mahatma Phule Krishi Vidyapeeth campus. Contacting farmers personally and recording their suggestions, opinions, and problems regarding electric motors, the survey was conducted.

Additionally survey of shopkeepers was carried out. Information regarding standard maintenance practices was collected from the manufacturer of electric motors. Ideal maintenance pattern details collected from the manufacturer is shown in Table 1.

Table 1 Periodic health check

Sr.No.	Details	Frequency
1.	Visual inspection	Daily
2.	Body temperature	Weekly
3.	Bearing temperature	Weekly
4.	Bearing noise	Monthly
5.	Grease condition	Periodic overhaul
6.	Starting noise	Weekly
7.	Winding	Periodic overhaul
8.	Air gap	6 monthly
9.	General cleaning and blowing with dry compressed air	Monthly
10.	Measurement of insulation resistance	6 monthly
11.	Overhauling	Yearly / 5 yearly Depends upon use

The information collected (Rao, 2000)

a) regarding precautions to be taken in maintenance of motors as under-

1. Well-trained personnel should carry out maintenance.
2. Appropriate supervision should be provided.
3. Safety precautions should be observed
4. Permit to work should be obtained.
5. Motors should not be energized accidentally while maintenance work is in progress.
6. Live – line maintenance should be limited to safe activities as permitted in the maintenance schedule.
7. Accidental contact with live parts / rotating parts should be avoided.

b) Regarding various activities of maintenance (Rao 2002) which can be performed without dismantling the motor as under-

1. Cleaning using vacuum cleaner or blower.
2. Lubrication of bearings.
3. Heating- Checking motor frame, bearing
4. Excessive vibration and noise.
5. Winding insulation

c) Steps in overhaul of a motor-

1. Visual inspection

2. Dismantling
3. Cleaning
4. Replacement of damaged parts and worn out parts.
5. Cleaning and impregnation of winding.
6. Replacement of bearing oil/grease.
7. Checking winding resistance
8. Drying-out.
9. Testing
10. Recommissioning.

By collecting the above said information following points were considered for data collection from farmers and shopkeeper's survey –

1. Type of motor
2. H.P. rating
3. Year of installation
4. Working Voltage
5. Application
6. Working hours
7. Problems in operation
8. Maintenance carried out
9. Cost

With these points actual status of electric motors in field was studied. During survey it was confirmed that electric and diesel pump sets owned by farmers had very high-energy index only because of improper installation, use of inefficient, poor quality accessories and improper maintenance.

Results and Discussions

As per survey carried out 77% motors are used for irrigation purpose and 23 % for drives purpose. Selection of motor is improper for irrigation purpose. Power rating of the pump sets used by the farmers was more and was mismatching with crop water requirement. In most of the cases, use of extra length pipes, bends, improper pipe alignment, insufficient foot valves in suction side reduces efficiency of system.

Besides these there are some more important issues that have come out from this study regarding selection of non-standard electric motor as well as starter. Before installation, such things should be avoided for trouble free, reliable and economic operation.

From the survey carried out some repeated problems are enlisted out as shown in Table 2.

Table 2 Frequently occurring problems

Sr.No.	Details	% Of occurrence
1.	Low head operation	3
2.	Bearing problem	3
3.	Faulty starter	11
4.	Loose connection	30
5.	Operation under low voltage	40
6.	Failure of oil seal	3
7.	Single phasing	2
8.	Entry of water in working motor	3
9.	Improper alignment	5

Majority of farmers are facing problem of low voltage. To overcome this motors operating at lower voltages up to certain level can be selected. If electricity connections are authorized one then by using boosters at distribution side voltage levels can be improved. To improve the power factor of whole system from economy point, proper rated capacitors can be used.

The simple but frequently occurring problem of loose connections can be avoided by checking all connections depending upon use and working conditions. While selecting starters care should be taken. Only branded starters at required ratings must be selected. For selection, competent person should be involved. Many times standard motor manufacturers are recommending ratings for all accessories that have to be connected to selected motor. Before commissioning of motor mechanical and electrical checking should be carried out by competent authority. Particularly proper alignment, control gear, bearings etc. should be checked. From electrical point, aspects like terminal marking and required direction rotation; earthing, tightness of connections, insulation resistance, overloading conditions should be checked. Periodically to avoid single phasing, a starter with single phase preventer should be used. Oil and water seals should be checked periodically. While replacing any parts, original spare parts must be used.

When motor is in continuous operation then overhauling is essential. It includes thorough checking, inspection, repairs, adjustment and restoring of good working condition. During overhaul, the machine is dismantled and worn out parts are replaced. Overhaul involves complete shutdown, dismantling, repair and reassembly. As per type of duty, frequency of overhauling is decided, as too much maintenance adds cost. The basic aim of maintenance work is 'Prevent trouble rather than allow it to occur and then deal with it'.

Motors are designed such as when something is going wrong they are indicating it another way. In most of the cases heating of motor takes place. Reasons for that as listed in Table 3.

Table 3 Causes of high temperature rise and remedies.

Sr.No.	Indication	Remedy
1.	Overload	Reduce load and improve cooling.
2.	Continuous run of short time rated machine	Run the machine as per assigned rated duty.
3.	Core and winding covered with dust	Blow down machine with clean dry air.
4.	Fan rotates in wrong direction	Reverse the direction.
5.	The blade of fan in wrong direction	Reverse the direction of fan blades.
6.	Cooling ducts clogged	Clear the cooling ducts.
7.	Improper cooling system	Check cooling system and rectify.

Along with initial or general checks farmers were reported different problems. The expert's solutions have been found and some suggestions are given to them as shown in Table 4.

Table 4 Problems occur during operations of electric motor

Sr.No.	Problem	Reason	Remedy
1.	Motor unable to discharge proper quantity of water	Motor operates under low head	Use proper HP rating of motor as per head operation.
2.	Motor makes noise and becomes hot	1. Failure of bearing 2. Rotor get jammed 3. Faulty operations of cooling fan	1. Due to lack of lubrication, sometimes rotor gets jammed. So timely lubrication is necessary. 2. Check cooling fan or replace it. 3. Replace bearing if failed.
3.	Motor becomes hot during operation	1. Rotor get jammed 2. Increase relay setting than standard 3. Lack of greasing	1.Use as per requirement 2. Timely lubricate all rotating parts.
4.	Motor unable to discharge required capacity	1. Loose connections of impeller 2. Loose connections of starter terminals	1. Tight on the connections. 2. Due to loose starter connections, low supply voltage may be resulting. Check it.
5.	Burning of coil during operation i.e. winding failure	1.Operation under low voltage 2. Increased relay setting 3. Continuous operation 4. Loose connection of main switch, starter, fuse 5. Failure of oil seal 6. Leakage in discharge pipe due to which water enters the motor 7. Single phasing 8. Manufacturing defect 9. Frequent start/stop 10. Bearing failure	1. Check supply voltage. 2. Select the starter as per specifications. 3. Use motor as per duty period. 4. Tighten all connections. 5. Periodically check oil seal or replace it. 6. Remove leakage in pipe. 7. Use single phase preventer. 8. Contact manufacturer. 9. Avoid frequent start/stop. 10.Check bearing or replace it
6.	Bearing failure	1. Misalignment of motor shaft 2. Loose components 3. Worn out bearing	1. Align the motor shaft. 2. Tighten all components. 3. Replace bearing if needed.

If maintenance is carried out as discussed above, it will improve the efficiency of operation and also economy can be achieved. The cost and economy observed due to maintenance are shown in Table 5 and 6.

Table 5 Maintenance charges required/year for 3 H.P. / 5 H.P. motors

Sr. No.	Items	Charges
1.	Grease 250 grams	50/-
2.	Oil seal	55/-
3.	Gland	20/-
4.	Coupling belts	30/-
5.	Nuts and bolts	100/-
6.	Servicing charges	215/-
7.	Starter servicing	120/-
8	Fuse wire	10/-
	Total	600/-

Table 6 Charges required to rebuild the motor due to lack of maintenance

Sr.No.	Motor HP	3 HP	5 HP
1.	Bearing cost	250	300
2.	Cost of coil	870	1160
3.	Petrol Cleaning	60	80
4.	Varnishing	80	100
5.	Cost of installation		
	a) Bearing	120	150
	b) Refilling	250	400
	Total	1630	2130

From the above analysis, it is very clear that due to proper maintenance cost saving of around 60 to 72 % can be achieved. Lack of maintenance also affects the performance of machine.

Consider a case where there was a need to pump 68 m^3/hr of water at 47m head. The pump characteristic curves (A....E) for a range of pumps are given in the Figure 1.

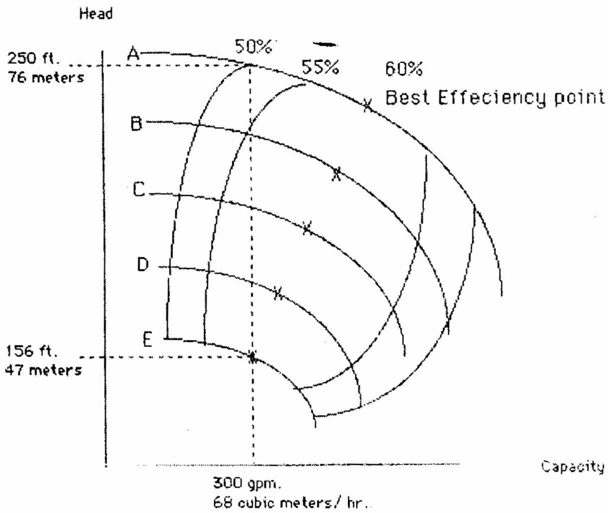

Fig.1 Pump Characteristic Curves

For selection of curve E, then the pump efficiency is 60%

Hydraulic Power = Q (m^3/s) × Total head, $h_d - h_s$ (m) × ρ (kg/m^3) × g (m^2/s) /1000

$$= \frac{(68/3600) \times 47 \times 1000 \times 9.81}{1000} = 8.7kW.$$

Shaft Power = 8.7 / 0.60 = 14.5 kW.

Motor Power = 14.5 / 0.9 = 16.1 kW (Considering a motor efficiency of 90% as recommended by manufacturer)

If curve A is selected, then the pump efficiency is 50 % and total head changed to 76m with reference to curve.

Hydraulic Power = 14 kW

Shaft Power = 14/ 0.50 = 28 kW.

Motor Power a) = 28 / 0.9 = 31 kW (Considering a motor efficiency of 90% as recommended by manufacturer)

b) = 28 / 0.75 = 37.33 kW (Actual efficiency of motor due to lack of maintenance of bearing)

Hence, additional power drawn by A over E is a) 31 – 16.1 = 14.9 kW.

b) 37.33 – 16.1 = 21.23 kW.

Extra energy used – a) 8760 hrs/yr × 14.9 = 1,30,524 kW (i.e. Rs. 5,22,096/ annum)

b) 8760 hrs/yr × 21.23 = 1,85,974.8 kW (i.e. Rs. 7,43,899.2/annum)

Extra energy of Rs. 221803.2 / annum is required due to improper maintenance. Part a) shows the effect of oversize pump while b) gives additional energy lost due to maintenance problem. The extra cost of the electricity is more than the cost of purchasing a new pump.

To avoid this, maintenance is essential. Farmers can carry out routine maintenance at their own. For breakdown or special conditions skilled persons are required. Adequate and timely energy supplied from motors put in for farm uses are also required to be ensured for exploiting full potentials of investments made. Along with the maintenance, improved farm machinery including irrigation equipment facilitates, use of agricultural inputs (land, water, fertilizers and chemicals) more efficient and consequently increase in productivity of land and labor.

Conclusion

- Around 77% motors are used for irrigation and 23% for drive purpose.
- Mostly monoblock, submersible three phase induction motors are used.
- Farmers are using 3 hp to 10 hp capacity motors.
- Actually submersible motor requires less maintenance but due to improper power supply, lack of technical knowledge regarding selection of motor and starter lead to various problems.
- Among the various power sources consumed per hectare, share of human energy was found to be more. For sugar cane electric energy consumed found to be more as compared to the other crops because of irrigation requirement for sugar cane.
- Finally it can conclude that because of proper maintenance economy and reliability in service can be achieved.

Acknowledgement

The present study was conducted as a part of final year design project of B.Tech.(Agril. Engg.) course guided by first author. The authors would like to thank final year students for collection of data. (Mr. Ahtare, Mr. Patil, Mr. Palve)

References

1. Anonymous. Report on Energy in Agriculture Maharashtra Scenario. Marathwada Agricultural University Parabhani (M.S.) 2005.
2. Anonymous. Report on Optimization of Maintenance of Electrical Motors Used in Agriculture. Department of Farm Structures and Rural Electrification, Mahatma Phule Krishi Vidyapeeth Rahuri. 2004.
3. Koppad, A.G., and Maurya, N.L. Performance of diesel pump sets, Karanataka J. Agric. Sci. 7(2) 1994 : 190-193.
4. Rao B.V.S. Operation and maintenance of electrical equipment. Khanna Publications 2000.
5. Rao, S. Testing, commissioning, operation and maintenance of electrical equipment. Khanna publications Fifth Edition, 2002: 892-903.

Reddy, K.S., et. al, Assessment of agricultural pumping systems in Chhattisgarh state J.Agric. Engg.38(1) 2001: 64-69.