

## How to Reduce Motor Drive Energy Cost

### Introduction

Most of the induction motors are designed to operate at their highest efficiency between 60% to 100% of their rated load. It has been observed that most of the motors used in industrial application are oversized and operate below their rated capacity. If a motor operates below 50% of its rated capacity then its efficiency will drop sharply and it will reduce the power factor of the system, which in turn increases the load on industrial electrical system. It is therefore strongly recommended that motors should be sized correctly depending upon the load driven by them so that they operate in their peak efficiency zone.

In an attempt to improve the efficiency of electric motor drives, generally focus is given on the motor itself and perhaps the controller. This focus may stem from a feeling that the motor is the end user of the energy supplied but the fact is that it converts electrical energy back to mechanical energy to be used by the driven load. Too narrow a focus may mean that larger, cost effective energy savings are being overlooked. Studies done by various national and international agencies show that only 20% of total energy savings are associated with improvements in the efficiency of the motors and the electrical supply system. To capture the balance 80%, all parts of the motor driven system including the driven load and process is to be examined in detail.

Savings in individual motor drives will vary from process to process. To estimate energy saving in motor drive system, one must take a system approach. All parts of the motor driven system, particularly the driven load and the process must be examined in detail for finding possibility to save energy cost. In larger plants this system approach may require a team effort involving management, process and engineering staff.

### A System Approach to Motor Drives

A motor drive system can be broken into a series of four inter – related component parts (see fig 1).

- Power Supply System: Electrical input power to the motor drive control system.
- Motor/Controller Subsystem: Comprising a device to control the motor and motor itself.
- Mechanical Subsystem: Comprising a drive train to link the motor to the driven load and the driven load itself.
- Process: Process itself means circulation of air, pumping of water etc.
- 



### Measures to Improve Efficiency

#### Opportunity 1: Electrical Distribution Correction

Measures available to improve power quality and reduce electrical losses are

- Maintain voltage level close to nameplate level as far as possible, with a maximum deviation of 5% (at 5% under voltage, copper loss is increased to 10%).

- Minimize phase imbalance within a tolerance of 1%. As deviation of one phase voltage from average phase voltage increases, it will result in increased winding temperature.
- Maintain high power factor to reduce distribution losses.
- Avoid excessive harmonic content in the power supply system, as increased harmonic content in power supply system will increase motor temperature.
- Use oversized distribution cable in the new installation to reduce copper losses. This will also help in reducing voltage drop during starting and running and minimizing the motor losses.

### Opportunity 2: Motor Efficiency Improvement

It is the traditional approach. The measures available to improve motor efficiency are:

- If motor is running at partial load then convert motor from delta to star connection. This will improve motor efficiency.
- Replace rewind induction motor (with reduced efficiency) with new energy efficient motor.
- If process demands oversized motor then possibility of use of VFD may be explored to save energy. This is also applicable in case of varying load duty cycle motor application.

\* Control the motor drive temperature. This will reduce copper losses and increase motor life.

### Opportunity 3: Better System Matching

Measures available are:

- Use an on/off control system using timer, PLCs, etc to provide motor power only when required.

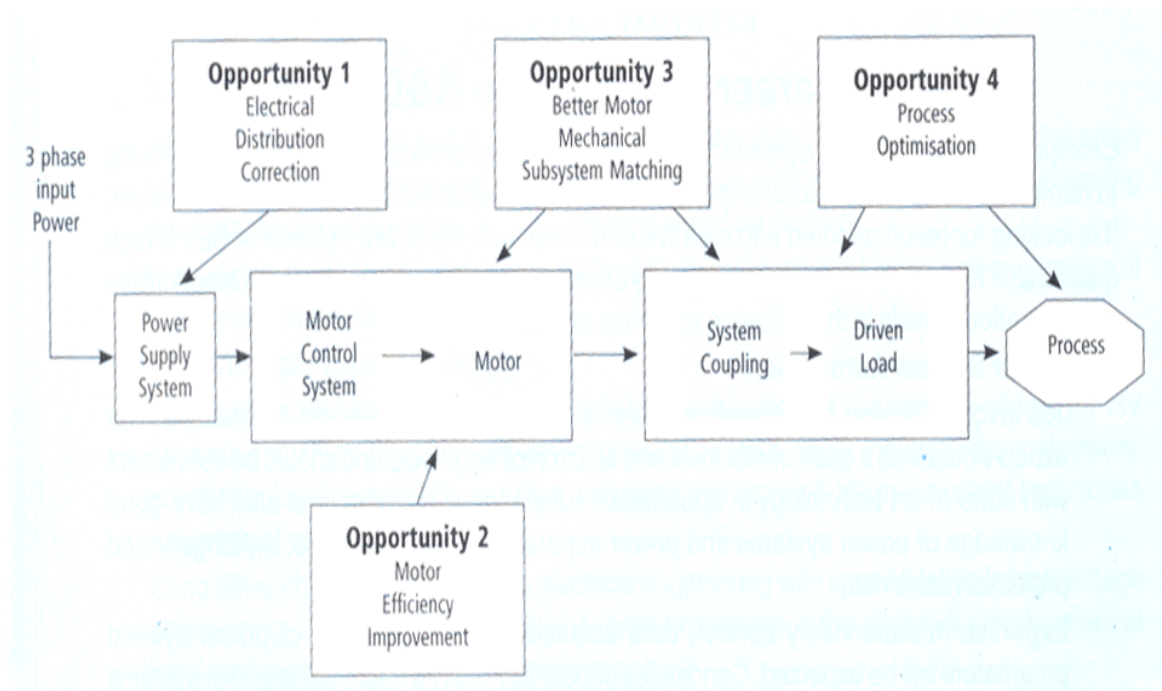


Fig 1 Motor Drive System and Efficiency Improvement Opportunities

- Size the motor to avoid insufficient low load operation. Motor should run at 65% to 100% of its name plate rating to get maximum efficiency.

## Opportunity 4: Driven Load and Process Optimization

Measures available to optimize the process and its operation are:

- Change or reconfigure the process or application so that less input power is required.
- Downsize the over sized pumps, fans, compressors or other driven loads if possible.
- Install more efficient mechanical subsystems. Check that coupling, gearbox, fan or pump must be energy efficient.

## Miscellaneous Measure to Improve Motor Efficiency

### Maintenance

Energy savings of 10 to 15 percent of motor energy consumption can typically be realized, depending on change from existing maintenance practices.

These are:

- Proper lubrication: it will minimize wear on moving parts. Lubrication is best done on a regular schedule to ensure wear is avoided. Once it occurs, no lubricant can undo it. It is crucial that the correct lubricant is applied in the right quantities.
- Correct shaft alignment: It ensures smooth, efficient transmission of power from the motor to the load. Incorrect alignment puts strain on bearings and shafts, shortening their lives and reducing system efficiency. Shafts should be parallel and directly in line with each other. It is necessary to use precision instruments to achieve this. Shaft alignment is an important part of installation and should be checked at regular intervals.
- Proper alignment: Belts and pulleys must be properly aligned and tensioned when they are installed, and regularly inspected to ensure alignment and tension stay within tolerances. Abnormal wear patterns on belts indicate specific problems that may require correction. Loose belts may squeal and will slip on the pulleys, generating heat. Correctly tensioned pulleys run cool. Excess tension strains bearings and shafts, shortening their lives.
- Painting of motor: Avoid painting motor housing because paint acts as insulation, increasing operating temperatures and shortening the lives of motors. One coat of paint has little effect, but paint buildup accumulated over years may have a significant effect.

## Team Approach

The most effective motor drive efficiency programmes have involved multidisciplinary team. Any substantial improvements in motor drive energy efficiency require capital investment, which means that management must be represented on the team. In fact the most successful motor drive efficiency programme has been those that have been initiated by the management. Also a concerted effort of the operation as well as the maintenance group is a must for achieving any improvement.

## Conclusion

In order to reduce motor drive energy cost, it is essential to have a system approach rather than to attack on any one portion of the drive energy system. This will not only reduce the energy consumption but also increase the system/plant efficiency.

## References

1. Efficient use of an Induction Motor by P N Salaria (CGL), Bombay, power Directory Journal.
2. Determining Electric Motor Load and Efficiency by Department of Energy, United States of America.
3. Energy Conservation in Induction Motor by Technology Trends, Nov 2001.
4. Guidelines for Repair/Replacement Decisions and Performance Optimization Published by EASA, June 2001.

## Reference Book:

IEEMA Journal (Energy Conservation Week 14-21 Dec., 2004)  
Energy Conservation Special Issue