Analysis of Motor Speed Requirement at Different pressure for Air Compressor Unit

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Abstract

Electricity is a high grade form of energy and therefore great effort is made to find cheap and efficient means for saving it. Growing Cost of energy calls for power saving at each possible steps of manufacturing. Electric motor driven system used in industrial processes consume more than 70 percent of electricity used in industry , hence best possible technology is being applied for achieving highest efficiency values. An energy-efficient motor produces the identical shaft output power (hp), but uses a lesser amount of electrical input power (kW) than a standard-efficiency motor. Energy- efficient motors must have insignificant full-load efficiencies that exceed the minimum NEMA standards. In this paper we calculate exact motor speed required for air compressor to run at lowest pressure. Variable speed drive system is used to control motor speed. Generally compressors are working at full motor speed at all pressure ranges. Due to this, eventhogh at low pressure requirement we have to run the motor at full speed i. e. either 1440rpm or 2880rpm. Hence electrical energy consumed by motor in all pressure ranges is same. In this article we calculated exact motor speed required for lowest range of compressor pressure by experimentally using variable speed drive unit.

KEYWORD : Optimize motor speed, variable speed drive for motors

1. Introduction

Compressed air is used in approximately all types of industries and records for a major share of Electricity used in various plants. It is utilized for a range of end uses such as pneumatic tools and tackle, instrumentation, conveying, etc. and is chosen in Industries because of its handiness and safety. Normally, the compressed air factor is an unnoticed area in most of the industries, though it is a costly source of power, about 7 to 10 times the cost of electricity. Given this economics, improved maintenance practices and eradication of wastage would aid in improving the performance of compressed air systems.

The electric motors are used to supply motive power to equipment such as compressors, pumps, blowers, etc. It is essential that the industrial users identify their need accurately to facilitate proper selection of a motor for a particular function. Of the total electricity consumed in the industrial sector, electric motors relation for roughly 70%.

The motors are classified in DC (direct current), AC (alternating current) synchronous, and AC induction (squirrel cage or wound rotor type) types. The AC induction is moreover distinguished as single or polyphase. Commonly power consumed by motors in the industry is accounted for by polyphase (three-phase) AC induction motors. Of the three-phase induction motors, the squirrel cage motor is mainly popularly used because of its relatively low capital and maintenance costs, and rugged design.

2. Tips for energy saving:

- The motors should be energy efficient.
- Convert delta to star connection for frivolously loaded motors.
- Install soft start-cum-energy saver for evenly loaded motors.
- In case of centrifugal-blower pump, install variable voltage frequency (VVVF) drives for speed control of motors.
- Install multi speed motor.
- Optimize operating voltage level of motor for lightly loaded motors
- Replace eddy current controls with variable frequency drives for varying speed driven equipment?
- Provide interlock for electric motor to avoid idle running
- Replace motor generating sets with thyristor drives.
- Avoid frequent rewinding of motors. Greater the number of rewind, lesser the efficiency.
- Carry out preventive maintenance and condition monitoring schedule regularly.

3. Advantages of Energy Efficient Motors

- Reduced operating costs
- Less heat losses
- Extended winding lifespan
- Extended lubricating grease service life
- Lower noise levels than other motors
- Reduced energy costs. The higher purchase price investment pays off.
- Reduce emission of CO_2 and NO_x greenhouse gasses from power stations for positive environmental effect.

4. Motor Speed and Enclosure Considerations:-

Energy-efficient motors are a valuable investment in all size, speed, and enclosure classifications. In general, higher speed motors and motors with open enclosures be liable to have slightly higher efficiencies than low-speed or totally-enclosed fan-cooled units. In all cases, however, the energy-efficient motors offer significant efficiency improvements, and hence energy and dollar savings, when compared with the standard-efficiency models. Typical motor efficiency gains are illustrated in Figures 1 through 3. Figure 1 shows the efficiency progress expected from the selection of energy-efficient over standard-efficiency motors with varying nominal speeds. The efficiency gains are usually largest for the 3,600-RPM motors. Figure 2 indicates that the energy savings associated with 1,800-RPM energy-efficient over standard open motors slightly exceed those available from the high-efficiency over the standard totally enclosed model. Figure 3 indicates that energy efficient motors provide even greater efficiency improvements when operating under part load conditions.

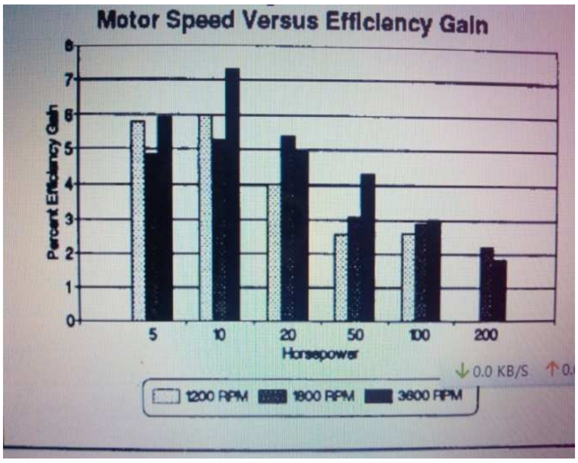

Fig 1 Motor Enclosure Vs Efficiency Gain

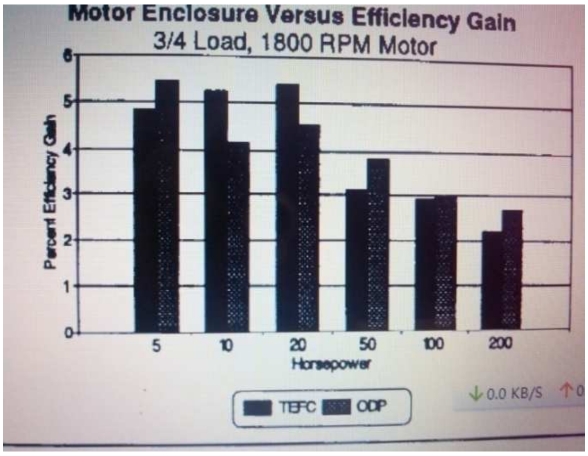

Fig2 Motor Enclosure Vs Efficiency Gain (3/4 Load)

5. Efficiency Improvements at Part-Load Conditions

Energy-efficient motors execute better than their standard-efficiency counterparts at both full and partially loaded conditions. Typical efficiency gains for 5-, 20-, and 100-hp motors when operating at full; 3/4-; and 1/2- load are given in Figure 3. Efficiency improvements from use of a premium-efficiency motor actually increase to some extent under half-loaded conditions. While the overall energy preservation benefits are less for partially versus fully-loaded motors, the percentage of savings
remains relatively constant. To obtain full-, 3/4-, and 1/2-load efficiencies and power factor information, consult WSEO's Electric Motor Database.

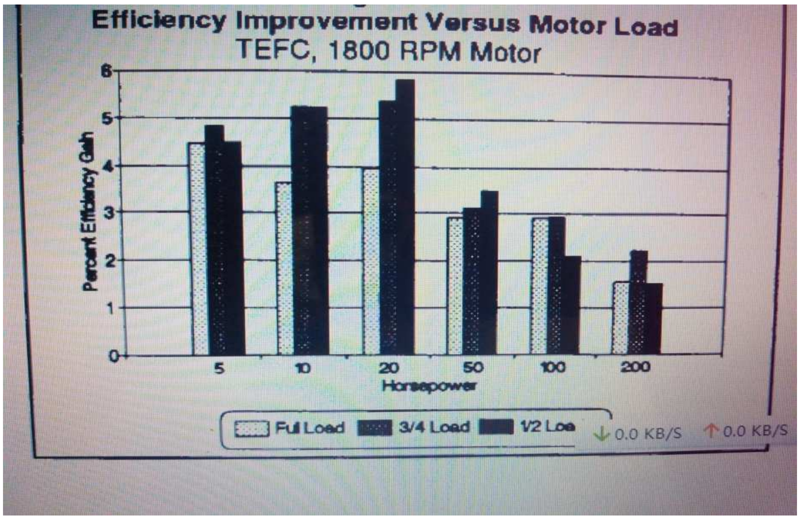

Fig 3 Efficiency Improvement Vs Motor Load

6. Motor Selection Considerations

Overall motor performance is related to the following parameters:
• Acceleration capabilities • Insulation class • Breakdown torque • Power factor • Efficiency • Service factor
• Enclosure type • Sound level • Heating • Speed • Inrush current • Start torque A good motor specification should define performance requirements and describe the environment within which the motor operates. As the purchaser, you should avoid writing design-based specifications that would require modification of standard components such as the frame, bearing, design, rotor design, or insulation class.

Specification contents should include:
• Motor horsepower and service factors
• Temperature rise and insulation class
• Maximum starting current
• Minimum stall time
• Power factor range
• Efficiency requirement and test standard to be used
• Load inertia and expected number of starts
Environmental information should include:
• Abrasive or non-abrasive
• Altitude
• Ambient temperature
• Hazardous or non-hazardous
• Humidity level

You should specify particular equipment requirements such as thermal protection, space heaters (to prevent
Moisture condensation), and whether standard or nonstandard conduit boxes are required.

6.1 Motor Enclosures

Many types of motor enclosures are existing , including:

6.2 Open. An enclosure with ventilating openings that permit passage of external cooling air over and around the Motor windings. This design is now seldom used.

6.3 Open Drip-Proof (ODP). An open motor in which ventilation openings prevent liquid or solids from entering the machine at any angle less than 15 degrees from the vertical.

6.4 Guarded. An open motor in which all ventilating openings are limited to specified size and shape. This
protects fingers or rods from accidental contact with rotating or electrical parts.

6.5 Splash-Proof. An open motor in which ventilation openings prevent liquid or solids from entering
the machine at any angle less than 100 degrees from the vertical.

6.6 Totally-Enclosed. A motor enclosed to prevent the free exchange of air between the inside and outside of the case, but not airtight.

6.7 Totally-Enclosed No ventilated (TENV). A totally enclosed motor that is not equipped for cooling by
means external to the enclosed parts.

6.8 Totally-Enclosed Fan-Cooled (TEFC). A totally enclosed motor with a fan to blow cooling air across
the external frame. They are commonly used in dusty, dirty, and corrosive atmospheres.

6.9 Encapsulated. An open motor in which the windings are covered with a heavy coating of material to provide protection from moisture, dirt, and abrasion.

6.10 Explosion-Proof. A totally-enclosed motor designed and built to withstand an explosion of gas or vapor within it, and to prevent ignition of gas or vapor surrounding the machine by sparks, flashes, or explosions that may occur within the machine casing.

7. VARIABLE FREQUENCY DRIVES

Variable frequency drives (VFDs) avoid wasting energy by specifically matching motor speed with
cooling requirements, which outcome in dramatic reductions in power usage.Affordable and factory installed in nearly all cases,VFDs are one of the most cost-effective ways to capitalize on efficiency and reduce operating costs.According to ARI (Air Conditioning and Refrigeration Institute) Standard 550/590-2003,chillers typically run 99% of the time at part-load (off design conditions). Therefore, having your chiller match your building’s load profile will offer both efficiency and comfort. To date, variable speed centrifugal compressors have been the best way to effectively decrease energy consumption throughout the majority of the operational hours. When variable speed is functional to a screw compressor, the savings are increased, since the variable speed screw chiller always provides the maximum amount of speed reduction.In order to fully appreciate the payback of variable speed screw water-cooled chillers, an understanding of centrifugal water-cooled chillers is required.

8. Experimental Procedures & Measurements:-

Experiment was conducted on 150 Psi capacity reciprocating Air compressor with 0.5 HP, 3 Phase induction motor @ 2880rpm. A 900X Solenoid pressure sensor is attached at delivery pressure valve which measure output pressure. Experiment is carried out by varying speed of motor with the help of Variable speed drive (VSD) at fixed the exact speed according to output pressure.
The observation table is given below:-

SN	Pressure (Bar)	VSD Load Value Reading	Motor Speed (rpm)
1	1	180	1776
2	2	175	1896
3	3	170	2010
4	4	165	2130
5	5	160	2250
6	6	155	2368
7	7	150	2484
8	8	145	2604
9	9	140	2724
10	10	135	2840

9 Result & Discussion:- Optimal solution obtained by reducing motor speed. The experimental results are obtained thus improving the utilization of electric power.

10 Conclusion: - It can be said confidently that by using Variable speed drive this compressor unit can save large amount of electrical energy in industries. Now by using compressor in above speed also reduces wear & tear of compressor components and also increases re placement period. These attribute will result in world class product that will satisfy the consumers. So we conclude that if a company applies this speed reduction method practically then there is positive change in their energy saving which will benefit company, suppliers and customers.

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