INFLUENCE OF LOW DELIVERY PRESSURE OF AIR COMPRESSOR ON MOTOR SPEED USING VARIABLE SPEED DRIVE

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ABSTRACT

For the same capacity, Air compressor required more electric power at high delivery pressure and vice versa. If we operate compressor at very high pressure which is not essential for desired application then it is only a waste of energy but also leads to a excessive wear, leads to further waste of energy. If we operate compressor at high pressure then its volumetric affiance get automatically reduced. There is a huge possibility of saving electric power as well as component life by lowering delivery pressure as well as lowering motor speed of compressor. In this paper we have used AT 8952 Micro controller to reduced motor speed with the help of variable speed drive unit. Of course operating a compressor at 8 bar instead of 5 bar which is sufficient to fulfill application requirement leads to higher consumption of electric units. In such leakage rate also increases. Ever effort has been made to reduce compressor pressure and motor speed to lowest possible setting. A reduction in delivery pressure by 1 bar would reduce electric power by 7 to 10 percent.

Keyword -- Energy Efficient Comressor, VSD Controlled Electric Motor

I. INTRODUCTION

1.1 Basic System

Before implementing energy reduction strategies in compressor, be familiar with all aspects of your compressed air system.

1.1.1 System supply

Evaluate the supply side of your compressed air system for the types of compressors used and the type, suitability and settings of capacity controls and other operating conditions. Understand the fundamental capabilities of the system and its various modes of operation.

Validate that air compressors are not too big for end uses. For example, an air compressor is oversized if the end use only requires air pressure that is 50 % of the pressure that the compressor is capable of producing.

1.1.2 System demand

Identify all the uses of compressed air in the plant with their pressure ranges. Quantify the volume of air used in each application and produce a demand profile, quantity of air used as a function of time, for the compressor. Equipment specifications for operations that use air are good resources for obtaining data on air volume use rates. The profile highlights peak and low demand. A general evaluation of compressed air use will help identify inappropriate uses of air.

1.1.3 System diagram

Develop a draft of your compressed air system—including compressors, air supply lines with dimensions, and compressed air end uses—to supply an overall view of the entire compressed air process.

1.1.4 Distribution system

Examine the distribution system for any problems related to line size, pressure loss, air storage capacity, air leaks and condensation drains. Corroborate that all condensation drains are operating properly because inadequate drainage can increase pressure drop across the distribution system.

1.1.5 Maintenance

Calculate maintenance reports, procedures, records and training. Ensure that procedures are inplace for operating and maintaining the compressed air system, and that employees are trained in these measures.

II. CONSERVATION STRATEGIES

Identify easy to execute energy conservation opportunities in your compressed air arrangement by conducting a walk-through assessment. Simple conservation opportunities can result in savings up to 25% of the current cost to run the compressor.

2.1 Leaks

Routinely check your compressor system for leaks. A distribution system under 150 pounds-per-square-inch gauged (psig) of pressure, running 40 hours per week, with the equivalent of a quarter-inch diameter leak will drop compressed air at a rate of over 100 cfm costing over $2,800 per year. In noisy environments an ultrasonic detector may be needed to place leaks.

2.2 Compressor pressure

The compressor must produce air at a pressure high enough to beat pressure losses in the supply system and still gathering the minimum operating pressure of the end use equipment. Pressure loss in a properly designed compressed air system will be less than 10% of the compressor's discharge pressure—found on a gage on the outlet of the compressor. If pressure loss is larger than 10%, evaluate your distribution system and identify areas causing excessive pressure drops. Every two pounds-per-square-inch decrease in compressor pressure will decrease your working costs 1.5%.

2.3 Identify artificial demands

Artificial demand is produced when an end use is supplied air pressure higher than necessary for the application. If an application requires 50 psi but is supplied 90 psi, surplus compressed air is used. Use pressure regulators at the end use to minimize artificial demand.

2.4 Inappropriate use of compressed air

Look for wrong uses of compressed air at your facility. Instead of using compressed air, use air conditioning or fans to cool electrical cabinets in industry; use blowers to agitate, aspirate, cool, mix, and inflate packaging; and use low-pressure air for blow guns and air lances. Separate the compressed air source from unused equipment.

2.5 Heat Recovery

As much as 80 to 90% of the electrical energy used by an air compressor is converted to heat. A properly designed heat recovery unit can improve 50 to 90% of this heat for heating air or water. Approximately 50,000 British thermal units (Btus) per hour is available per 100 cfm of compressor capacity when running at full load.

For example, consider a 100 hp compressor that generates 350 cfm at full load for 75% of the year. If 50% of heat loss is well again to heat process water, the savings, at $0.50 per them, would be about $4,100 per year in natural gas.

2.6 Inlet air filters

Maintain inlet air filters to stop dirt from causing pressure drops by restricting the flow of air to the compressor. Retrofit the compressor with large-area air intake filters to help decrease pressure drop.

2.7 Compressor size

If your compressor is extra-large add a smaller compressor and sequence-controls to make its operation more capable when partially loaded. Sequence-controls can regulate a number of compressors to equal compressed air needs, as they vary throughout the day.

2.8 Air receiver/surge tank

If your compressed air system does not have an air receiver tank, add one to buffer short-term demand changes and reduce on/off cycling of the compressor. The tank is sized to the power of the compressor. For example, a 40 hp air compressor needs approximately a 40-gallon air receiver tank.

2.9 Cooler intake air

When in taking cooler air, which is more intense, compressors use less energy to generate the required pressure. For example, if 90o F intake air is tempered with cooler air from another source to 70o F, the 20o F temperature drop will lower operating costs by almost 3.8%.

2.10 V-belts

Routinely check the compressor's v-belts for accurate tightness. Loose belts slip more frequently which reduces compressor efficiency.

III. ENERGY SAVING AIR COMPRESSOR

Why save energy?

Energy efficiency in compressed air has turn out to be a key issue on every Finance Directors and Plant Managers agenda. With ever increasing costs of energy the have to generate compressed air in the most energy efficient method possible is of dominant importance. Every rupee saved is straight off the direct cost of the business and therefore provides major benefits to all companies be they large or small concerns. Direct Air are able to propose advice and recommendations for all areas of your industry concerning the energy efficient generation and use of compressed air with a pro active approach committed to providing energy efficient solutions therefore driving down the cost of running your system.

Furthermore, you may be eligible for an interest free, energy-efficiency loan from The Carbon Trust towards the cost of your energy savings solution

3.1 Energy Survey

Undergoing an energy survey is repeatedly the first step to improving the energy efficiency of your compressed air unit. Direct Air exploit the most advanced energy surveying equipment to audit all areas including generation, treatment, distribution and process usage. With energy costs ever increasing the require to control the cost of your systems compressed air is becoming increasingly important. Direct Air's engineers will install state of the art logging equipment which will permit us to forward a detailed survey on your compressed air systems condition with meticulous reference to energy and the operating efficiency of the system.

Following a full analysis of your systems energy and air usage Direct Air will forward a report on potential ways to generate energy savings via various methods dependent upon your site specific needs.Direct Air are committed to providing energy efficient solutions for your sites air compressor requirements.

3.2 Retrofit Variable Speed Drive

If you have a variable air demand profile on site yet have enough air compressor capacity then why not change an existing air compressor to Variable Speed? Direct Air offer retrofit variable speed drive systems that are designed for utilize with all rotary screw air compressors and include the essential components to complete integration of the drive with the compressor. The drive will convert an existing fixed speed air compressor to a variable speed drive air compressor and is fully compatible for integration with the Energy Air compressor control system.

3.3 Leak Detection Service

Compressed air leakage is accurately pouring money down the drain!! Direct Air provides a comprehensive leak detection service that will assist in reducing your company's levels of compressed air utilization and therefore reduce the cost of generation. By using state of the art ultrasonic leak detection equipment even the smallest of leaks can be identified.

The table below highlights the level of wastage created by the smallest of leaks.

Hole Diameter (mm)	Air Leakage@7bar(Cfm)	Power Required(Kw/h)
0.5	0.4	0.06
1.0	1.7	0.24
1.5	3.8	0.54
2.0	6.6	0.93
6.0	60	8.5
10	165	23.4

Table 1 Air Leakage rate Chart

IV. EXPERIMENTAL DESCRIPTION

- For Experiment 150 pound reciprocating air compressor is used with 0.5HP 3 phase induction motor @2880rpm and variable speed drive unit.
- Electronic circuit has prepared with AT 8051 microcontroller witch give signal to variable speed drive for speed control
- Our aim of this set up is to reduce speed of motor according to desired pressure pressure.

Fig 1. Experimental Set up in Laboratory

- In this experimental set up we reduces speed of motor at low pressure requirement so that we can save electricity. If we suceed to reduce speed of motor then automatically reduces voltage and current requirement which leads to reduces units consumtion.

- Every different application needs different air pressure magnitude. With that respect we maintain motor speed. For example if we need 8 bar pressure then motor runs nearly at full speed but we need 5 bar pressure definitely this set up reduces motor speed less than requirement in 8 bar pressure.E/p I/p 900X pressure sensor (Transducer) is used to control outpur pressure. It senses output pressure and give signal to electronic circuit for reducing motor speed.
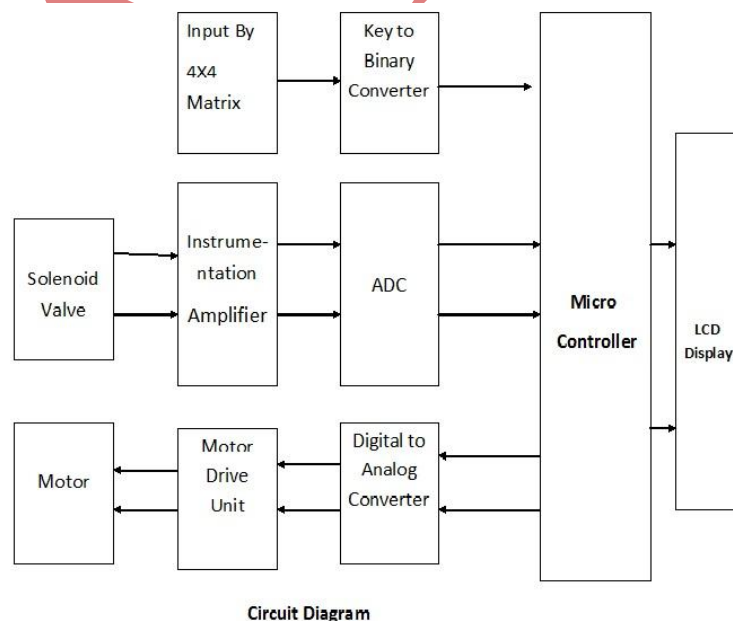

Circuit Diagram

Fig 2. Circuit Diagram of Set up

- Experimental set up is connected as mentioned in above figure. LCD display shows input pressure as well as existing pressure inside the tank.

- If receiver tank is full of pressure say 10 bar and our application requirement is 5 bar in such case motor will be shifted to stand by mode i.e. not in running condition. This standby position is maintained till receiver pressure reduces to 6 bar.

- As soon as receiver pressure reaches to 6 bar Soleboid valve senses that pressure and give signal to microcontroller for motor start. In that situation motor start running at 2250 rpm instead of 2880 rpm.

- In above statement we have found two benefits. One is speed difference and another one is time difference. Both are reduces our electrical energy cost.

- If we run the motor at 2250 rpm instead of 2880 rpm definitely voltage and current consumption get reduced which affect to reduces electrical unit consumption.

- Total 22sec motor keeps in standby mode which also saved large amount of power.

V. OBSERVATION TABLE AND CALCULATION

SN	Pressure (Bar)	VSD Load Value Reading	Optimum 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

Table 2. Optimum Motor speed required for different pressure range.

If compressor run 1896rpm for supplying 2 bar pressure.

Voltage= 160V , current =1.18 amp

Power P= VxI

P= 160 x 1.18=188.8watt

1Kwh=1unit

(188.8x1)/1000= 0.1888 units

For 1 day = 0.188x24=4.5312 units

Commercial per unit cost is Rs 10

One day cost is =4.5312x10=Rs. 45.31

If compressor run 2130 rpm for supplying 4 bar pressure.

Voltage= 180V , current =1.25 amp

Power P= VxI

P= 180 x 1.25=225watt

1Kwh=1unit

(225x1)/1000= 0.225 units

For 1 day = 0.225x24=5.4 units

Commercial per unit cost is Rs 10

One day cost is =5.4x10=Rs. 54

The cost difference per day is nearly Rs 10

VI. CONCLUSION

It has been observed that if we used optimum pressure for particular application then we definitely saved electrical units by lowering motor speed. This aspect is more important in those industries which are running compressor in all time. In this experiment microcontroller chip is used with Embedded system programming which is chiipest set up at mass production. In this paper the aim has been to determine a Power saving Compressor in all aspect i.e. electric cost as well as maintenance. This set also help reducing wear & tear as well as volumetric efficiency.

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