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Research Article

Energy Saving and Solution Proposals Compressors and Electric Motors

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Abstract

Many countries are dependent substantially on outside financial sources. Ever-growing energy need indicates significant problems which would be seen on energy in the future. Today, consumers have to use energy in more productive way. Even if it is an advantage to obtain energy by different sources , it has got a great importance t use existing energy in saving. From this point of view, improvements related to the productive usage of energy in industry facilities which energy is mostly consumed and the productivity studies should be started. Studies related to energy saving can be made on electric motors and compressors which are mostly used especially in industry facilities with energy productivity policies which will be applied. So energy productivity is provided in industry field in many countries and also these countries' competitive capacity can be increased with developed countries as the current costs' are decreased. Thus, aforementioned countries' foreign-source dependency can be reduced in energy.

Keywords: Energy efficiency, Compressors, Electric motors, Efficiency, Industrial associations.

1. Introduction

The increasing energy demand indicates that there will be energy crisis over world in the future. Consumers which go in for the leading edge in consuming energy are industry institutions. Industry institutions have caused much more consumption with the developing technology in every passing day. Thus , the point which will be mostly considered besides the production methods of alternative energy is the productive and saving usage of energy.

Many countries are dependent substantially on outside financial sources and they meet their energy gap through the importation. That these countries are dependent on outside financial sources for energy production reduces their competitive capacity on industry sector. Thus , studies related to the increase in energy production capacity and the productive usage of energy should be concentrated on.

The dependency on foreign-source energy can be reduced on energy supply by energy productivity studies which will be made on industry institutions which are the greatest consumers. Primarily, studies to raise awareness both of technical personnel and management staff which employ in industry institutions can lead towards points of productivity and points which are demanded on saving.

Energy crisis which would occur for many countries can be precluded by significant saving policies which would be made in this field. Moreover, it can be availed on the increase of competitive capacity for aforementioned countries with the decrease in cost per unit of energy. Thus, it can be contributed to energy productivity with saving methods which will be used in compressors that have got role in consumer which is used mostly in industry institutions, in electric motors, pumps and lighting systems.

2. Energy Saving on Compressors

That hot air which compressors creates during its running on systems which compressor is used with the increase of electric energy cost and also the ddvekoping environment awareness is given out before it is used has gained importance by means of energy saving. Heat which occurs while compressors are making the application of squeeze-off is removed by water-cooled heat exchanger and fan means. In order to make air pressure on compressors, more than 90% of the spent electric energy can be regained as energy. The sample of compressor views has been given at Figure 1.

Figure 1. The Sample of Compressor View

If electric, gas or liquid fuel is used by means of heating during production or process phases on industrial facilities, there is possibility to reveal heat energy which one of these methods will be obtained partly or fully from compressor. While the regained heat energy gain is determined, the heat levels which will be obtained determine in the possible usage areas. For example; when it is considered that 94% of energy which is spent on a water-cooled oilless compressor would be regained in a way that it would obtain hot water of 90°C , a saving which will be made in this way will be an important point to decrease costs. [1-5].

That compressors are extensively heated while they are running obliged to cool compressors for the continuity of running. There are many methods which are used to cool compressors. Generally, cooling system is used by oil and water. In basic meaning, compressors can be cooled

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to some extent by means of the oil and water cycle with compressor. As a result of cycle, temperature of these substances increase considerably. A considerable extent of energy saving can be gotten as this extensive heat which is revealed out is regained by a few of cost effective methods. It will have been provided that nominal water's temperature increases considerably without being extra fuel consumption on companies which need hot water consumption. If the company does not need hot water consumption for the process, energy saving can be gotten as such a system is used in heating in winter months Aldo. It is possible to increase samples by suchlike process case.

In the cases that nearly all of heat which compressors reveal out before they use it are used, it is seen that the system amortizes itself in a process which is less than 2 years. For example, on an air-cooling system, when it is assumed that a compressor is worked in full load and capacity for 6 months in a day in a year , the annual analysis of regaining amount for heat which occurs in compressor will have been done. If we estimate that the heat which will be regained is gotten from electric energy which is 0,07€ per kWh, the amount of saving which will be made in the annual basis is 9,347€.[3-7].

The pressure air amount which will be used in industry institutions differ generally in the usage phases. For example, the quick changes can be seen in the pressure air amount which will be used by study hours of machine pieces in manufacturing institutions and the speed of pieces which are produced. In another example, the pressure air amount can change at the ratio of 50% by thickness of yarın which will be used for the weaving in a facility which makes production in the weaving sector.

In the studies which have been made in European Union in recent times, 20-40 % of energy which is spent on compressors which is used for long time in a day is unnecessarily consumed in such these applications and it shows that energy which is unnecessarily spent would be regained [6-11].

If it is generally considered , if the compressors do not work in full load, the changing pressure air that they give can be arranged as an inventer is used.

When the need to the pressure air decreases in compressors, energy saving would be done by a precise control as the deceleration of compressor is provided by the controlling motor speed and as the working of motor at nominal level by the increase of need.

Standard-screwed compressors are treated by the principle that the load does not work. Compressor will start to work out-of-gear without producing ait until air pressure which will be produced in compressor get to the upper-limit pressure value. When air pressure in the system reaches to lower limit value, compressor will start to reproduce air.

According to results from many studies, it has been observed that compressors are generally on the load at the range of 50-70% of working time. This rate explains how high waste air is without producing air [9-14]. Moreover, losts that sudden high currents which are gotten from network at first blush and source from natural structure of methods such as classic star-triangle starting cause them can be showed as sample for it. As choosing compressor ; the following cases should be considered that these are the determination of correct capacity and peak necessity in the consideration of all equipments, the determination of hourly /daily/weekly consumption map and working pressure by the most distant consumption place, the determination correctly of load and usage factors, the determination of compressor type and air quality by need, the determination of machine which has got capacity consumption in the best feature, and that capacity consumption is low as compressor is out-of-gear [5-12].

Choosing the air tank at appropriate size, the design and placement of pipe lines , choosing pipe diameters properly and airing compressor room are other factors to affect on productivity on compressors also.

When the effect of air pressure on the way out on compressors are considered, another situation that energy in pressured air systems is wasted in significant amount is to provide opportunity for that air is unduly compressed as unduly pressure is used on equipments. As the value of pressure increases so it is known that energy which is necessary to compress air increases. When it is considered from this point, the lowest pressure value which would be used as equipments that are used in pressure air are reviewed should be determined. Correspondingly, the pressure value which is on the way out of compressor should be arranged. If it is necessary, equipments which use pressure at different level should be fed from different compressors. The lowest level could be reduced in losts which would occur as pressure is provided to be reduced much more by the usage of regulator at the head of line separably. Today, solution have been tried to be produced as both of theoretical-calculated-numeric and other practical methods are used in relying on such productivity seekings [7-18]. These studies include network-sourced productivity researches, detailed studies such sas working signal and sometimes methods which will work in energy production from renewable energy sources [1,2,6,11-17].

3. Energy Saving on Electric Motors

It has been seen that nearly 70% of electric energy which is used in industry is used for electric motors [3]. A great part of electric energy consumption in industry institutions consist of electric motors in nearly each field of industry. With the data, many countries will have provided energy saving in large amount with energy saving at low amount which would be provided on electric motors.

Before industry institutions supply electric motor, energy need of these electric motors is not generally considered. Yet as it would be seen at Figure 1, 97% of total cost in the working time of an electric motor consists of energy expenses. Its rest which is its 3% consists of purchasing, montage and maintenance expenses [1-5].

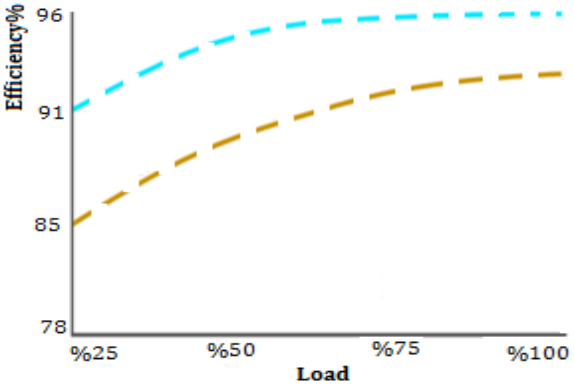

Figure 2. The Effect of Loan in Motor Shaft on Output

On researches which includes 2500 electric motors that 25 companies use them; it has been observed that the usage of EFF3 efficiency-class electric motor is at level of 85% , the usage of EFF2 efficiency-class motor is at level of 14% and the usage of EFF1 efficiency -class electric motor is at level of 1%. In the case that an electric motor which has expired(nearly 12 years) is changed with EFF1 instead of EFF2 , repayment process is 5-21 months. In the case that an electric motor which has not expired is changed with EFF1, its process is 16-56 months. In the case that variance speed driver is used in pressure ait systems, repayment process is 5-18 months. The potential of energy saving in electric motors is stated at Table 1 [6-14].

Table 1. Energy Saving Potential on Electric motors [2]

Precautions to Take for Energy Saving	Saving Potential (GWh/year)
Not Being Packed of Ustulate motors	600
Being removed of missings on pressure air systems	2600
Being worked on load which is close to its power	400
Use of high-output (EFF1)	1300
Use of variable speed driver	2000

Electric motors should be chosen in direct proportion to load that they work and the habit to choose a larger electric motor which would work the load should be given up. Thus, it should be prevented that electric motors work in low capacity and so in low efficiency by their nominal capacity which is stated in data sheets. As the load increases in electric motors, so the efficiency increases and the efficiency of motor reaches the maximum level generally at the load of 75%. Electric energy which consumed in low loads is turned into heat in the increasing rate instead of mechanic capacity and it reduces the life of electric motor as it increases the failure risk from an extensive heating in electric motors [1,2].

For example, a fan of 75 kW is worked on average performance by an asynchronous motor. Meters show that only an energy of 22.5 kW is used in real. Accordingly, when a saving calculation is made:

It has been seen that the efficiency reduces in 72% from motor efficiency graphics and so capacity factor reduces in 0.48%.

Real mechanic capacity which is needed =22.5x0.72=16.2 kW.

An electric motor of 20 kW in full load has got an efficiency of 89% and capacity factor is 0.9%.

Current capacity = 16.2/0.89=18.2 kW

If the annual working process is taken as 8400 hours;

The annual saving =4.3 x 8400= 36.120 kWh and it is seen that this capacity factor is better one [1,2].

One of the most important factors which provides energy saving in electric motors is the use of electric motor driver cycles by capacity electronic devices. Especially, that first working current is quite high in medium- large-capacity electric motors causes that the possibility which electric motor damages on windings is quite high and equipments' working times decreases in time. When soft starters and electric motor drivers are used, disadvantages that this case causes will have removed. Moreover, energy saving is provided in large proportions with the aid of electric motors cycle direction, their speed change and also on their start-stop cases. Electric motor drivers which are used in the consideration with industry companies' current cases are amortized by means of their costs in quite short times. As those who work in companies use only measuring devices, it would be seen exactly in what extent the energy saving is after they compare an electric motor which is worked by electric motor driver cards and an electric motor which is worked without electric motor driver cards.

Motors features and their working cases should be peridocally noted after electric motors are listed in companies. As a constant voltage and current measurements are done on important points and especially on high capacity motors , an opportunity will have been provided to the intervention in time for care of motors. Thus, it would be precluded that windings of electric motor burn as motors are constantly kept under the control.

The unbalanced supply voltage causes that positive and negative component currents occur , so it affects substantially on the efficiency of electric motor [10-14]. For example, while the difference between EFF1 motor and EFF3 motor on an asynchronous motor of 75 kW is 1%, an imbalance of 2.5% on the supply voltage can reduces the efficiency of an asynchronous motor at 1.3% or the laxity on belt and bulley mechanism can cause on losts nearly up to 5%. Thus , it is important that motor parameters are always followed for an efficiency companies and motor failures are determined early. Generally, as motor parameters are not followed online in industry , losts which occur due to failure and negative company conditions are not determined. Thus, motor condition monitoring and predictive maintenance have become more important than ever. In order to mention on the efficiency improvements in motors in industry , motor parameters are definitely to be followed as online and predictive maintenance is to be done [11-14].

In the case that an unbalanced supply voltage is applied in an electric motor of 100 Hp, 1800 d/d , the change in the efficiency is showed at Table 2 [2].

Table 2. The Effect of Voltage Unbalance on Motor Output [2]

Motor Load	Voltage Unbalance		
	Nominal	%1	%2,5
%100	%94,4	%94,4	%93,0
%75	%95,2	%95,1	%93,9
%50	%96,1	%95,5	%94,1

As the imbalance of voltage at high levels will make vibration and mechanic knockings on induction motors, it reduces the life of motor. The imbalance of voltage in line will affect negatively in the working of protection system as it causes extensive losts on stator and rotor [9].

Voltage fluctuations are among factors which affect on quality of capacity. Motors should not be worked on a voltage which is more different than 10% of voltage on sign plate. High voltages affect negatively on motor temperature, its speed and vibration. Low voltages can causes that motor is extensively loaded during the starting. The effect of voltage fluctuations on motor efficiency is showed at Table 3 [14-21].

Table 3. The Effect of Voltage Fluctuations on Motor Efficiency

Performance Chart	The Effect of Voltage Change		
	On voltage of 90%	On voltage of %110	On voltage of %120
Standard Motor Output			
Full on Load	An increase of %0,5-1	A decrease of %1-4	A decrease of %7-10
¾ on load	A decrease of %1-2	A decrease of %2-5	A decrease of %6-12
½ on load	An increase of %2-4	A decrease of %4-7	A decrease of %14-18

4. Points to Consider in Order to Determine on Our Electric Motor Need

The determination of motor needs provides energy saving and decreases the failure risk. The proper security factors should be considered by the cases that load moment is stable or varying, by the cases of extensive loading. As depending on the structure of motor, it is quite important to determine on the proper starter tool. Type and features of mechanic load should be determined and the shaft capacity should be determined by definite type and features. Moreover , it is necessary to determine on motor class and characteristics.

In the case that motor capacity is chosen as small one, an extensive heating, the increase of shear, the decrease of cycle will reduce the capacity and efficiency of work. In the case that the capacity of motor is chosen as high one, energy expenses will increase as institutions and companies' costs, the efficiency of motor and the coefficient of capacity will decrease. In the case that motor protection type is not chosen as proper one, powder which accumulates on windings and ball catches in dust , the rusting of roller in aqueous media and the lost of windings' insulation feature can cause the burn of motor. In the case that the type of cooling is not chosen as proper one, motor which is not cooled at sufficient level can burn in short time.

Many studies have been done both in our country and in the world to contribute energy productivity by using smart and micro networks]. With this aim in recent years in scientific literature the number of researches about elecrical devices and on usage of renewable energy sources in industrial plants has been increasing to benefit from sun energy at maximum level. Today theoretical studies towards productivity in energy-optimization by using either artificial neural nets (machine learning) or other statistical estimation methods (gamma, castigating etc.) with different methods have been continuing in science world besides all these applied conservation and productivity studies.In many studies new suggestions are given for economical usage of equipments having high consumption such as compression, pump, motor with filtration methods especially in industrial plants. In our country studies of electrical train and rail systems having high electrical consumption that are planned to be built by public by the year 2016, are encountered [7-29].

5. Conclusion

Generally, industry institutions in our country are established without considering necessary sub-structure studies , so too much energy wastage is not made as feasibility studies are not made by the efficiency principles. When it is considered from this point, energy wastage cam be prevented as necessary saving studies are made.

The regain of heat can be provided as the heat which is wasted on compressors that will be used in the production of pressure air is used again. The system would take industry institutions' working costs to the lower levels with the regaining of energy in a project which its planning phase is rationally prepared.

During the working of compressors, energy which confronts us substantially as inert heat can be used. The saving can be provided by the usage of the heat on heating water procedures instead that the heat at high degree is given out distemperately.

On studies which have been made in literature in recent times, it is seen that 20-40% of energy which is spent on compressors which are used in long term in a day is consumed in such applications distemperately and energy which is wasted unnecessarily would be regained.

While the selection of motor is made by the preference of high-efficiency electric motor as buying electric motor, that it is chosen in consideration with needs of the process requires that the low-efficiency motors which complete 12 years are changed with high-efficiency motors. Systems can amortize themselves in very short time as energy saving in significant amount is made by the usage of varying speed drivers when the regular controls of periodic maintenances for electric motors are made by the preference of motor at nominal capacity.

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