Journal of Scientific & Industrial Research
Vol. 79, October 2020, pp. 951-954

Role of Automation in Energy Management and Distribution

Manish Saraswat[1]*, Kamal Sharma[2], Nathi Ram Chauhan[3] and R K Shukla[1]

[1]Department of Mechanical Engineering, ABES Engineering College, Ghaziabad, UP, India
[2]Department of Mechanical Engineering, GLA University, Mathura, UP, India
[3]Department of Mechanical and Automation Engineering, Indira Gandhi Delhi Technical University for Women, New Delhi, India

Received 22 July 2019; revised 5 February 2020; accepted 18 April 2020

This paper discusses about how automation plays its role in achieving sustainable energy management in broadly two aspects, industries and homes. Industrial or factory automation has its own benefits, and techniques have been evolved to cut down the power usage to significant levels of the conventional ways using Variable Frequency Drives (VFD). Home automation is equally important, controlling electrical appliances through microcontrollers and saving electricity automatically detecting their usage needs. It also discusses about the requisites for energy management and the economic aspect of using energy management systems.

Keywords: Factory automation, Microcontrollers, Sustainable energy, Variable frequency drives

Introduction

Heat Energy management consciousness has been attained to such a level that has never been seen before. Depleting resources, environment consciousness among people, high tariff during peak hours adding to the cost of production, energy supply constraints at some places are the key drivers for energy management.

Traditionally energy is considered as a cost that is inescapable in manufacturing and the only way to minimize it is to reduce its consumption. But now it is being viewed as an input to manufacturing like materials or labour. Just like any other raw material, it can also be managed and optimized to cut down the cost of production. Likewise in any other system wherever energy is being used, can be managed to optimize its utilization.[1,2] Various factors responsible for an effective and sustainable energy management are illustrated in Fig. 1.

Pre Requisites for Energy Management

Any system can be turned into an energy efficient system by having proper knowledge of few basic aspects. These include energy consumption by equipments in any process, energy usage patterns throughout the process etc. These requisites are common for energy management at industrial or household level, with little or no variations.[3,4]

a. Understanding Energy Consumption of Equipment

This can involve machine OEMs as they have a much better insight of how the machines perform in different operating conditions. A more clear perspective on precisely the amount of the general vitality is being devoured by the assembling procedure and equipment.

b. Metering

Collect data about peak energy demand, energy usage patterns, build up patterns or errors in vitality quality and utilization and to set up benchmarks for further modification.

c. Inspection

Conducting audits and assessments to identify convert will support to minimize utility. Here verifying the data recorded is very important.

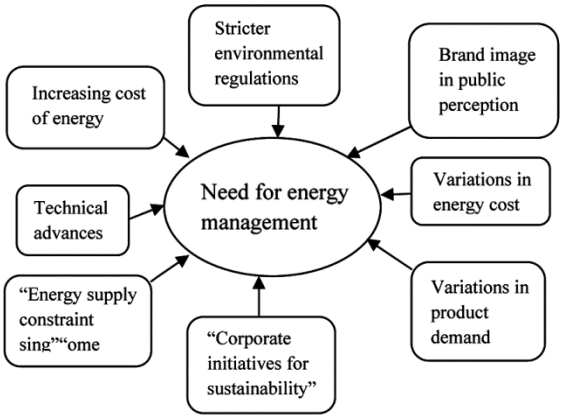

Fig. 1 — Factors responsible for an effective and sustainable energy management

*Author for Correspondence
E-mail: er.manishsaraswat@gmail.com

d. Optimize

Data gathered while metering and inspecting is consolidated into a solitary computerized arrangement that can distinguish, model, envision and present control alternatives.

Here comes the role of automation control systems. Luckily, the essential mix of computerization and data gives arrangements that are accessible to screen, measure, model and control assets for ideal benefits.

Optimization through Automation

Automation has taken control over the industrial and other control processes from the humans and handed it to the control units, which automatically take decisions, control and manage the processes reducing human intervention. A precise and continuous control is achieved over the processes when operated by these controlling units. When the governing is made through control units, a higher level of control is achieved which along with the data from study of the power consumption patterns help in energy management.

a. Industrial Equipment Control Units

Commonly, engine driven applications represent around 70 percent of all out mechanical vitality utilization. Since vitality represents a large portion of the working expense in mechanical applications, vitality proficient techniques for running engines can have a critical effect to add up to vitality utilization and working expenses. This can be easily achieved by making use of Variable Frequency Drives (VFD).[5,6]

There are various industrial processes where heating, ventilation and air conditioning (HVAC) is done. Industrial buildings are maintained at desired atmospheric conditions with the help of heat exchanger systems, air-conditioning, and air supply & exhaust system and various other systems. Large fans, pumps driven by electric motors are used in industries. These fans or electric motors consume lot of energy when driven at full speed. When driven at a lesser speed significant drop in energy consumption can be achieved without compromising with the desired end result. All this can be incorporated with the knowledge of power consumption patterns and with the help of controlling the speed through VFDs.

b. Energy Management Through VFDs

Variable frequency drives are the control units which can control the speed of an electric motor by controlling the frequency of alternating current being sent to the motor. The formula for shat speed is:

$$\text{Shaft speed} = \left((120 \times \text{F}) \div \text{P}\right) - \text{slip} \quad \ldots (1)$$

F is frequency of alternating current; P is number of poles in electric motor.

Electric motors are designed keeping in mind full load operations but depending on the operation usually load available is less than full load. When a motor runs without speed control, it is actually running at full load even when it is not necessary. VFDs provide a solution to this situation, altering the frequency of current being sent to the motor hence making considerable energy savings. Beside this VFDs provide soft start to enormous engines and slowly incline the engine up to speed forestalling over the top burden punishments. VFDs are close solidarity genuine force factor (at any rate .95 PF) compare to diminished vitality use. Some VFDs recover power which can be directed back to the framework and this is how intelligent motor control can be achieved.

Additionally outward loads offer the best potential for vitality investment funds by utilizing variable recurrence drives (VFDs) to control speed. Vitality utilization in outward fan and siphon applications observes the liking laws, which implies that stream is relative to speed, pressure is corresponding to the square of speed, and torque is relative to the block of speed. That implies if an application just needs 80 percent stream, the fan or siphon will run at 80 percent of evaluated speed and just requires 50 percent of appraised power. At the end of the day, decreasing rate by 20 percent requires just 50 percent of the force.[6]

c. Home Automation

Most of the energy that is consumed in a household is by the HVAC system, and then comes the other needs like hot water, kitchen, laundry and other electrical appliances. As indicated by measurements, structures devour 40 percent of all vitality on our planet.

In office buildings and hotels, environmental comfort is achieved through various systems working together. These include heat exchanging framework, cooling observing, natural air framework checking, air supply and fumes framework checking, water supply and seepage framework observing and lift framework. For accomplishing vitality the executives it needs to have adequate data about the condition of offices to design vitality protection.

Today's smart homes and intelligent office buildings are being well equipped with automated lighting and electronic devices. These are again interconnected with each other through master controllers which control and manage all processes.

For instance these control systems can automatically sense the presence of the humans and adjust the conditioning to the user defined settings. These can turn off lights, set back HVAC (heating ventilation and air conditioning systems) depending upon the presence of the occupant. Moreover these can even tell when the energy consumption should be scheduled so as to enjoy cheaper electricity.

Economic Aspects

Cost is one of the factors of utmost importance in carrying out any industrial activity. Any technology is not adopted till the point it assures benefits in terms of revenue generation or by other means. There are numerous examples where the use of automation in energy management has proven to be economically beneficial to the manufacturers.

Let's consider an example to calculate the savings that can be made in consumption as well as in the electricity bill on using VFDs, a fan operating at 300 RPM producing 100% flow rating of 2500 cubic meter per minute, along with a shaft power need of 25 kilo watt. Fan operates for 8000 hrs a year with a tariff of INR 5 per unit. When operated at full speed with no control available, its yearly operating cost comes out to be (25 kW) (8000 hrs) (INR 5) = INR 1000,000 per year.

To decide potential investment funds from control technique, a heap profile must be created. For this model the heap profile is chosen to be illustrated in the Table 1. Power calculation for VFD method is as listed in the Table 2.

Cost of operating with VFD control system, (13kW) (8000 hrs) (INR 5) = INR 520,000/year, hence a saving of INR 480,000/year.

There are several similar examples. Rockwell Automation enables General Mills to spare $2.6 million every year through an institutionalized vitality the board framework for air taking care of units. Investment made is of $6 million; hence the payback period is of about two and a half years. It is generally between 1.5 to 3 years depending on the facility, as shown in Fig 2.

Another example of VFDs energy management is as follows. The office in Guelph, Ontario, Canada produces a huge number of huge amounts of glass fiber every year. One of the difficulties for the Guelph site was to discover approaches to diminish the vitality expenses of the fans on a basic cooling area of the procedure. Owens Corning planned to diminish the speed of the 125 Hp cooling fan and of the three

Table 1 — Heap Profile

"Flow"	"Duty Cycle"
100%	20%
75%	40%
50%	40%

Table 2 — VFD Method

"Flow"	"Duty Cycle"	"Power Required" "kW"	"Weighted Power" "kW"
100%	20%	25 (1.0) = 25	25 (0.2) = 5
75%	40%	25 (0.55) = 13.75	13.75 (0.4) = 5.5
50%	40%	25 (.25) = 6.25	6.25 (0.4) = 2.5
Average Annual Power			13 kW

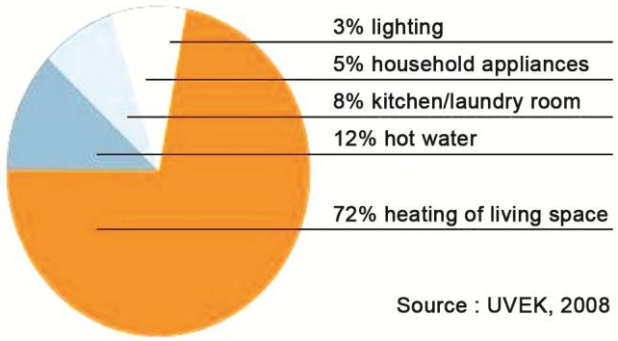

Fig. 2 — Energy consumption in private household

40 Hp distribution fans on the stove, while not influencing the trustworthiness of the item.

Utilizing constant metering hardware, the plant engineers assessed the potential investment funds of introducing variable recurrence drives (VFDs) on the fans, and confirmed that diminished fan speed would not influence item volume and quality. By utilizing VFDs, this venture meant to decrease the fan paces to 80 percent for 50 percent vitality reserve funds, with rate of profitability in less than one year. Diminishing the fan speeds likewise contributes extra preferences, for example, longer engine life, expanded wellbeing and decreased utilization of flammable gas by the broiler burners.

Further, a frozen yogurt maker may choose crude materials or delivery decisions that will bolster a perfect maintainability score simply like the present vitality proficient star rating. The organization may pick a dairy put together not just with respect to the cost of the milk, yet additionally on the potential carbon outflow caused in transportation of the milk to the office.

Conclusions

Energy management is itself an approach towards sustainability, which means acting in a responsible

manner with respect to future generations – at an economical, ecological and social level. Energy is often compared with the equivalent carbon dioxide emission resulting from generation of that much amount of energy hence saving electricity means reducing carbon dioxide emission indirectly.

Automation provides a solution for energy management through controlling various processes which are otherwise out of human reach to control. The investment made in automating the systems is recovered in very less time and also add to the profit in long run.

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