DOI: 10.37394/232024.2021.1.7

Business Administration for the production system of the processing industry

FLAVIUS SARBU
Department of Engineering and Industrial Management
Transylvania University of Brasov
500036 B-dul Eroilor, nr.29, Brasov
ROMANIA

Abstract: The first part of the paper discusses the necessity of developing an energy saving programme, and presents the main energy consumers of industry and the significant weight held by energy related costs in the turnover of production systems in processing industry.
Further the paper describes and analyses the steps to be followed in developing an efficient energy management programme. These are:
- appointment by the administration board of a manager for energy related issues;
- an energy audit, including a complete inventory of the energy consuming equipment, the diagram of the process flow, a general view on the operation practice, answers to a list of specific questions;
- identification of opportunities and their economic assessment;
- prioritising and grouping them into the fields of: lighting, drives, cooling, ventilation, heating;
- approval of the energy management programme by the administration board;
- implementation of the approved programme, starting with the engineering design part required by each established measure.

Keywords: energy management, energy consumption, industry

1 The necessity of development an energy saving programme

In the economy of a country of a certain level of industrial development, the most significant energy consumer is industry, particularly the metallurgical, chemical and raw material processing branches. In Romania, in processing industry, the main weight in energy consumption is held by the already traditional branches: machines manufacturing, electrical industry and wood industry.

These consumptions are included in the manufacturing cost of a product and consequently in its degree of market competitiveness. With the increase of energy costs, the prices of a number of products of the Romanian industry have grown too, and due to their consequent inefficient cost-performance ratio they have been forced out of the market. in order for these products to re-enter competition, the specific energy consumptions should decrease in average by about 2.5 times, simultaneously with an obvious increase of product performances [1].

If in the metallurgical and chemical industry energy saving can be achieved mainly by technological amendments involving significant investments, in the processing industry considerable reductions of the energy consumptions can be obtained also by process studies and optimisation of the processing methods and procedures.

In principle, in the processing industry, in accordance with the technological process, parts follow a specific route, including working posts, where the processing corresponding to a certain operation is carried out. For each type of surface to be processed on a part several, either conventional or unconventional procedures can be employed, the selection of the optimum one being determined by the surface shape, the processing precision, the material to be processed and the cost of processing. The processing cost also includes energy costs, directly determined by the efficiency of the processing system.

A major reduction of the specific energy consumptions of the processing industry needs to include studies and analyses of the subsystems composing by the processing system.

The analyses will be then expanded upon other energy consumers involved in the operations costs of the production systems.

A study completed in the U.S.A. has shown that in the industrial sector the main consumers are the electric motors, melting processes, primary and secondary heat treatments, electrochemical separation and lighting processes. Thus electric motors employ 67% of the electrical energy utilised in industry. The second and third position are held by lighting with 12% and electricity based heat processes, respectively [2].

Another study conducted by a commercial company representative for the machines manufacturing branch of Romania has also highlighted the significant weight of costs generated by the use of electrical energy in the operation of the system, that is 73% of the total of energy costs [3].

If further taken into account that at the same company energy costs represent 12.5% of the turnover, the development and implementation of an energy management programme follows as a necessity for increasing the efficiency of electrical energy use, as part of both the manufacturing process and the other components of production systems.

2. The development stages of the management programme

An efficient energy management programme calls for the involvement of the administration board and for the appointment of an energy manager, who should know and comprehend what kind of energy and in what quantity is used by the system.

A first stage of the programme development consists in the analysis of the energy bills of the last 12 months. The high energy consumptions between October and March indicate the use of additional energy for heating, while an increase during the summer months is a sign of intensive air conditioning use. A larger demand of energy during one month can be attributed to deficient operation or to an increased production, while a lower demand may reflect a partial disruption of the production system operation.

Conversion factors based on the heating power of the fuel will be employed for the analysis of different variants of efficient use of energy.

The energy monitoring technique frequently employed by energy managers resides in comparing the energy bills with those of previous years, of identical periods. Such comparisons, which can be conducted for the unit of fuel and its cost will highlight the trends of energy consumption and allow an analysis of changes.

The second stage in the programme development refers to the energy audit. The analysis of the bills identifies only the area of potential problems. The alternatives of increasing the efficiency of energy use can be established only by an energy audit, which implies several steps.

The *first step* involves obtaining a complete *inventory* of the energy consuming equipment. For this, starting from the plans of the buildings diagrams are plotted, which specify the characteristics (dimensions included) of the walls, windows and roof, followed by a *diagram of the process flow.*

The inventory of the equipment needs to include: the motors driving the machines, also the compressors, heaters and coolers, ventilation and air conditioning equipment, lighting supports, etc. A detailed inventory simplifies the assessment of opportunities and the development of a maintenance programme. For motors the type should be specified, the operation mode, power and working speeds(s). Lighting supports will be grouped by source type (fluorescent, incandescent, etc.), lamp type, ballast (the starting element of gas discharge), voltage, power, number of lamps on one support and type of support.

The *second step* of the audit includes a general view on the operation practice within the production system. How many hours a day does the system operate and when is the equipment used? What controls are there possible? What are the temperatures and the set of established points? is the equipment fully used? How well is it maintained? This way equipment can be identified, which operate both during working hours and outside them, lights and equipment left to operate idly, by negligence.

Based on the data obtained consequently to these two steps, a manger can estimate the energy consumed by various users and identify opportunities of reducing energy costs. The evaluation can be carried out with or without computer aid.

The *third step* includes the answers to the following list of questions:

- which is the weight held by energy cost in: the turnover, the production cost, in relation to profit?
- by how much have these weights been reduced over the last three years?
- what reductions of the energy consumption have been achieved in the last year, by what methods, in relation to what type of energy, at what cost?
- what is the budget allocated for the reduction of energy consumption for the following years and what profit will the allocated investments yield?
- what is the efficiency of the use of electrical energy in the production system?
- which are the consumptions and efficiencies in each profit centre, section, for each piece of equipment?
- which is the distribution of the energy consumption among processing machines and equipment, heating, transport, lighting, air conditioning?

The opportunities identified during the energy audit require an economic evaluation by means of costs.

In the case of investments, most production systems use the concept of recovery time for an economic efficiency indicator, that is the period in which the consumed resources could be recovered by the value of the annual profits made by selling the products.

Regardless of the methods employed for evaluation, the costs related to installation, annual operation, energy saving and updating in dependence on bank interests have to be known. The total cost has to include also the cost of the feasibility study, of engineering design, of the building process and of the equipment. A recovery time of 2 –3 years is considered acceptable for most production systems, but in accordance with the policy of the production system also shorter or longer periods may be admitted. [4]

Often, in evaluations the cost of maintenance or annual operation is ignored. Thus, for example, the replacement of a d.c. motor by a variable speed a.c. one reduces annual maintenance by the elimination of the carbon brushes in the second case. A 100 W high pressure sodium (HPS) lamp with a service life of 24,000 hours costs 64 value units (V.U. – Euro, Dollar), while a 500 W incandescent lamp resists for 1,000 hours and costs 7 V.U. If equipment which works 3,000 hours/year the incandescent lamp is replaced by the HPS one, having about the same light flux, then the annual operation cost for the HPS lamp would be:

$A.O.C._1 = 64 \text{ x } 3,000/1,000 = 8 \text{ V.U.}$

while for the incandescent lamp:
$A.O.C._2 = 7 \text{ x } 3,000/1,000 = 21 \text{ V.U.}$

this later one having to be replaced 3 times in a year.

A much larger saving is added to these cost reductions, due to the reduction of the annual consumption by:

E.R. = (500 W – 100 W) x 3,000 hours = 1,200 KWh.

At an average tariff of 43 V.U./MWh a saving of 51.6 V.U. is achieved, while the annual saving would be of 64.6 V.U. superior to the initial investment in purchasing the HPS lamp.

The smaller costs are also determined by a longer service life of the equipment. Economically efficient equipment have longer-than-standard service lives. Thus, high efficiency electronic ballasts and motors last 5 years longer than conventional ones. The savings achieved due to longer service life of the product are more suggestive and evident than a simple comparison of the recovery times.

The development of technology over the last years has allowed the development of energetically more efficient products. For example, the electronic ballast used in the new fluorescent lamps ensures together with these a reduction by more than 40% of the energy consumed for comparable light fluxes. Variable speed electric motor drives save 30 – 40% of the energy consumed in traditional actuation.

3 The measures included by the programme for increasing the efficiency of electrical energy use

Following evaluation, the selected opportunities are presented to the Administration Board and then, for the ones approved the next step is engineering design and implementation.

The measures included by a programme for increasing the efficiency of electrical energy use, detailed and carried out by the energy manager can be grouped by certain fields:

Lighting

- The replacement of the lamps currently in use with energetically efficient ones, as for example the replacement of incandescent lamps by fluorescent ones, the replacement of standard fluorescent lamps by energetically efficient fluorescent ones, the recovery time being less than one year.
- The utilisation of high intensity discharge (HID) lamps, which include those with mercury vapours, metal halide and high pressure rhodium, these being 2... 4 times more efficient than incandescent lamps, the recovery time being 1 … 2 years.
- The utilisation of electronic starting elements (ballasts), the required charge per element being by 12 W smaller than in the case of electromagnetic ones.
- The utilisation of speculative reflectors (S.R.) which ensure a 40% increase of the energetic efficiency in relation to the standard one, the recovery time being 2 … 3 years.
- The introductions of activity sensors, which detect the presence of employees in the monitored area and, in their absence, automatically turn off the light, the recovery time being 2 years.

Drives

- The replacement of standard electric motors by energetically efficient motors for the drives of fans, pumps, compressors, refrigerators at powers of 0.5 … 300 HP, thus ensuring 5 … 10% efficiency increases for small motors and 3 … 4% for large ones; the recovery time is influenced by the number of operation hours, the price of energy/unit, the dimensions of the motor and the time when the standard motor is replaced.
- The replacement of the constant speed a.c. motors with motors of the same type but with smaller rated loads, if the effective loads represent less than 0.7 of the rated one.
- The utilisation of a.c. variable drives, by controlling the feed voltage frequency; thus an average of 22.5% of the energy consumed by standard motor drives is saved.
- The utilisation of automatic decoupling devices of motors in no-load operation, used for machine-tools, conveyors, pumps and fans from the painting systems and fans from the exhauster system.
- Feeding the compressors with higher density air taken from a low temperature zone.
- Reducing the compressed air losses due to deficient sealing in the pneumatic driving systems, easily detectable during lunch breaks or after working hours when the level of noise is reduced.

Cooling, Ventilation, Heating

- the utilisation of room cooling equipment of an efficient energy rate (E.E.R.), superior to that of old equipment. The EER represents the ratio of the cooling effect expressed in heat units (KJ/h) and the consumed energy (in Wh), in order to obtain this effect in certain operation conditions. A new unit of 12,000 KJ/h mounted on the window and of EER 9 consumes during one season (1,500 operation hours) a quantity of energy 1,000 KWh smaller than a unit of the same capacity but of EER 6.
- The utilisation of air conditioning systems of variable air flow, by controllable fan speed. When supplying a correctly determined quantity of air, the system maintains the desired warm or cold air, saving 15 … 30% of the energy consumed for heating by a traditional system,

and 25 … 35% of the energy required for the drive of the fan.

- The recovery of energy from heat sources wasted by burnt gases, the cooling of the air compressors, of the cooling system compressors, condensers and exhauster processes and by using the recovered heat for room heating, hot water supply, in drying and treatment processes.
- The increase of water and vapour tank efficiency by eliminating excess air, detected by measuring the level of oxygen in burnt gases.
- Introduction of economisers into the burnt gas exhaustion tubes, meant to pre-heat the water fed into the tank.

By implementing as many as possible measures of the ones included by the programme significant energy savings are achieved, which will ensure a major increase of the competitiveness of the products obtained by the production system.

References:

[1] Ivan, M. - Energy *consumption reduction possibilities in the large production systems of machines manufacturing industry*. SIMPEC 98, vol. III., p. 14 – 19, Braşov, 1998

[2] Hodson, W.K. *Mayhard's Industrial Engineering Handbook*, McGraw-Hill Inc., New York, 1992

[3] *** S.C. Roman S.A. Braşov. - *Analysis of the Energy Consumption of the Company in the Year 2000*), martie 2001

[4] Gandhi, N. *Industrial Energy Management Success Using I.E. techniques*, IIE Conference, Toronto, 1989.