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Research Article

Behavior of Energy Indicators in a Factory of Electric Motors for Agriculture

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Abstract

Energy consumption is part of most of all the processes in the modern world, as such, it has an important participation in agriculture, and it must be rationally used in such a way that its losses are minimal and its cost rational according to the tariff system established in each region.

The objective of this work is to assess the behavior of the indicators associated with the consumption of electrical energy in the manufacturing process of the motors whose final destination will be to be part of the irrigation systems.

To the extent that the production of electrical machines is efficient, it will contribute to the reduction of the costs of the irrigation system for this concept, having a favorable economic impact in obtaining the agricultural product with adequate sustainability.

An electric motor factory that produces this line of equipment for agricultural irrigation in Cuba is taken as a reference, the production analyzes of the factory and its contribution in terms of sustainability and productive chaining of irrigation systems in the country are carried out.

Keywords: Energy, Efficiency, Quality, Sustainability

Introduction

The decrease in production costs is one of the most worrying topics in the agricultural sector, where energy consumption is at the same time an element of concern. For this reason, energy efficiency in agribusiness and reducing economic costs are the main challenges for the sector, since it allows productive work to be much more competitive and more sustainable.

In the agricultural sector, it is not possible to speak of energy efficiency in irrigation processes, because the pumping systems are not well dimensioned; therefore, the optimal parameters demanded by the sector are not reached. Even irrigation systems that are inefficient in themselves are used; for example, flood irrigation instead of technical irrigation [1].

To achieve energy efficiency, it is advisable to consider the redesign of the systems, assess the requirements that the crops want in terms of water, and consequently design the best equipment for pumping, taking into account the local development program.

High-efficiency motors and frequency inverters can play a decisive role in reducing energy consumption. Replacing, for example, obsolete or old pumps or pumping systems with high-efficiency pumps, with high-efficiency motors, will have a positive impact on energy efficiency, even more so when frequency inverters are present within that system. Now, it is necessary to consider that not by installing a high-efficiency motor or a high-efficiency pump we are going to ensure lower energy consumption; it is also necessary to ensure that the working and operating conditions of that engine are efficient and ensure the results, but, indeed, they are very important [2].

The decrease in energy consumption, we could say energy savings, will depend on how efficient the installed equipment is, how the operation is controlled and the general design of the irrigation system. Currently, it is not enough to have a technical system if it is working inefficiently and without considering other factors for proper operation. Today, to mention examples, it is mastered at what time of the day irrigation is to be carried out and in terms of

crop requirements and environmental conditions, in turn, the water that the plant will actually need is determined.

The case study is the production of motors of different capacities for agriculture of a company based in Cuba, the decrease in their production cost means a favorable economic impact for agriculture.

Materials and Methods

AThe ISO 50001 standard is a voluntary international standard developed by the International Organization for Standardization (ISO) to provide organizations with an internationally recognized framework to manage and improve their energy performance. Its foundations are those used in this study.

Energy performance is a concept that is related to energy efficiency, the use of resources and energy consumption and to analyze its behavior, specific indicators are established according to the activities carried out in the object of study.

The electricity billing analysis is carried out, a section that is part of the Energy Diagnosis, a section that integrates the Total and Efficient Energy Management Technology. The legal basis is Resolution 435 of 2017, which establishes the Tariff System in force in the energy country in order to review the parameters that provide penalties for the payment of electricity, such as the electrical power factor and the maximum contracted demand, both aspects. They have a decisive weight in the monthly amount to be paid and influence the monthly cost per kWh, which is also an indicator of energy performance.

Systematically monitor this aspect of electricity billing mu st on a monthly basis in production entities in general because they constitute a saving opportunity that must be taken into account.

In addition, the system tools established in the Total and Efficient Energy Management Technology are used, which consists of a package of procedures, tools and specialized software, applied continuously, with the philosophy and principles of total quality management. , allow establishing in a company or budgeted unit new habits of management, control, diagnosis and use of energy, aimed at taking advantage of all opportunities for saving and conserving energy, and reducing energy costs and associated environmental pollution [3].

All the materials and methods that are used to complete the study should be mentioned.

Results and Discussion

The Ministry of Agriculture and the "Motores Tauba" Base Business Unit of Holguín, belonging to the Heroes of July 26 Company, subordinate to the GESIME Business Group and the "Manuel Piti Fajardo" workshops, from Manzanillo, and agricultural services, from San Ramón, achieved the casting and machining of the first nationally manufactured electric pump (Tauba R-ML).

The 3-kilowatt equipment sucks at a depth of 26 feet and propels at a height of 30, capable of irrigating more than five hectares, has 94% of components of national origin, which would allow technological sovereignty, and its cost is less than those existing in the international market are. Such features allow it to cover areas under sprinkler or gravity irrigation, and work with volumes of water under pressure or by flow, depending on the request.

Its correct use can generate yields that exceed seven thousand tons of food.

The first designs work in the areas of Cuchillo, La Platica, Mota, Los Guayos, with more than a year of exploitation and results similar to those imported, territories belonging to the eastern part of the country.

In addition to producing motors destined for irrigation systems in different parts of the national territory and with diverse technical characteristics: for example, three-phase motors whose capacities range between 1.5 and 3kW, with a frequency of 60 HZ, among others, destined for the production company for irrigation specifically for the business unit that produces pumps, equipment that will be used to irrigate various crops, vegetables, meats, etc., in the agricultural sector facilities.

Figure 1: Production of electrical machines.

It is of great importance for the recovery and manufacture of electric motors, mainly those developed specifically for Plus 2000 forage machines, imported by agriculture. The solution that can re-

place large imports through future production of these machines in the country, contributing to the sustainability of this activity.

The production that said Base Business Unit has maintained has not been stable, except at this stage when the COVID-19 disease arrived in the Caribbean country.

The graphs shown below specify the monthly productive rhythm considering the first semester of the year before the measures to close the productive institutions were taken.

Given the measures that were taken as a means of containing the progress of the epidemic and the work that was being carried out in order to achieve product certification by the ISO 9001 and ISO 50001 Quality standards established throughout the business sector of the country, a task that has been resumed due to the need to recover the productions.

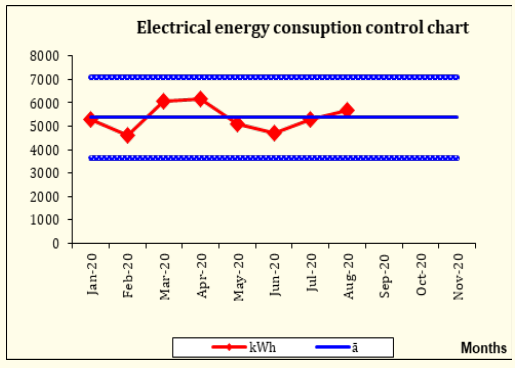

Figure 2: Electrical energy consuption control chart.

As can be seen, the electrical energy is controlled within a predetermined range.

Regarding the coefficient of determination, it shows that the existing correlation between the units produced and the energy expenditure is not yet adequate to the acceptable parameters (R2 = 0.67), but it is close to the established range, on scale 3 as a linear correlation regular, shown below [4].

Scale 3

- Perfect R = 1
- Excellent R = 0.9 < = R < 1
- Good R = 0.8 < = R < 0.9
- Regular R = 0.5 < = R < 0.8
- Poor R < 0.5 (6)

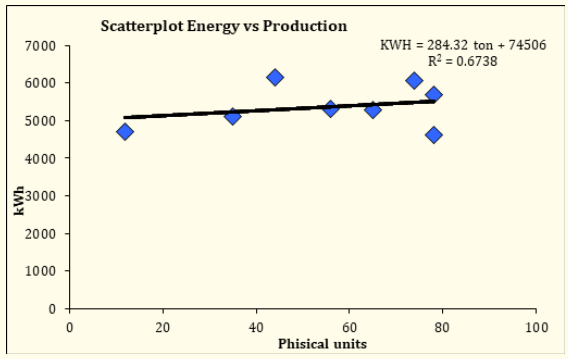

Figure 3: Scattetplot Energy vs production.

The analysis of the graph shows that the energy not associated with the production process takes an approximate value of 5000 kWh, which constitutes a reserve for the continuous improvement process established in the IS0 50001 standard and gives way to the following action that establishes identify opportunities to improve the entity's energy performance [5].

One of the aspects that is imposed in the analysis of energy indicators is the monthly cost of the billed kWh.

This analysis must be carried out on a monthly basis, assessing the real behavior of the Maximum Demand contracted to the Electric Union. The value of the Power Factor in the month must be taken into account, taking into account Resolution 277 of 2014, which establishes the current tariff system in the country (issued by the Ministry of Finance and Prices) and which establishes the acceptable values of behavior of these parameters. The established ranges are as follows:

Power factor <0.9 is penalized

Power factor = 0.9 it is not penalized or rewarded

Power factor > 0.92-0.96 receive bonus

In this case, the review of the sample corresponding to the conceived analysis period is carried out, assessing that according to what is billed, the penalties for low power factor represent 17% of the monthly electricity payment. This deficiency can be eradicated with reagent compensating means, obtaining a short-term bill reduction in accordance with the previous percentage, in addition, if it is possible to obtain a value of the power factor greater than 0.9, the greater benefits because the received bonus reduces the billing amount for the month.

Regarding the maximum contracted demand (fixed component of the Electricity Bill), which is currently 100 kW, it really fluctuates around 50 kW as a monthly average. The national tariff system establishes that the demand price is 7 CUP (national currency). for each kW, therefore, if the annual contract is readjusted with the supply agency, adjusting the demand to 60 kW, leaving a conservative margin, a monthly saving of 280 CUP and an annual saving of 3,360 CUP (national currency) is achieved.

The control actions of both indicators can be executed and it is possible to reduce the kWh cost indicator by 18% of the value before carrying out the analyses.

This reduction is reflected in the decrease in the production cost tab of electric motors.

Verifying the remaining productive and service activities, it is observed that billed electricity consumption includes operations that are not specifically associated with the production of electric motors. It is necessary to establish a system for measuring electricity consumption by areas that allows the calculation of an equivalent consumption index representative of the variety of assortments that are produced

This action makes it possible to delimit activities not directly linked to production.

For the execution of the method of equivalent production in an entity from the energy point of view (knowing the characteristics of the company in question and the different productive activities that are developed in it) it is necessary to process a large amount of information.

This primary information must be obtained from the company's production department, which has the technological charter for each of the machines and the electricity consumption for each of the production processes. Subsequently, the control variable must be defined, in this case, electricity, and a base period must be set to regulate the products with the highest consumption and refer the remaining production processes to it [2].

Rejection production, that is, production that is not endorsed by the established quality system, must also be controlled, because it is an electrical energy used without sales support and that constitutes a variable cost that can be reduced by identifying the causes that originate it [6].

Rejection production (not certified by the established quality system) must also be controlled, because it is an electrical energy used without sales support and constitutes a variable cost that can be reduced by identifying the causes that originate it [7,8].

Conclusion

In the present work, an analysis has been carried out on how to adapt two energy efficiency indicators applied to electricity in the TAUBA Motors Base Business Unit.

Through the systematic analysis of electricity billing and the establishment of a representative physical indicator that considers the topics discussed above, better economic impacts will be obtained in the Basic Production Unit, due to the reduction in the cost of electricity.

Through the establishment of an Integrated Management System that groups all the subsystems that intervene in the entity's operation and the application of the existing regulatory framework, it will be possible to speed up the process of continuous improvement to obtain better results in the productive levels of the entity.

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