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SUBSTANTIATION OF REPLACEMENT OF THE OBSOLETE EQUIPMENT ON THE EXAMPLE OF ASSESSING THE ENERGY EFFICIENCY INDICATORS OF AIR BLOWER

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Annotation: the assessment of the current state of consumption of fuel and energy resources (FER) of the enterprise and its comparison with standard values, as well as drawing up a fuel and energy balance and developing a program to improve the energy efficiency of the enterprise play an important role in the analysis of the energy efficiency of electric energy. As a result of the implementation of these measures, it is expected that the energy consumption at the enterprise will decrease by 5%. [1] An analysis of the efficiency of using electric energy on the example of air blower is given in the article. In the context of modern requirements for energy saving and increasing production efficiency, an analysis of the energy efficiency of industrial equipment becomes an urgent task. This article covers the energy efficiency indicators of the air blower model 1111-3725/04 with synchronous motors GYS 3/2 based on the instrumental measurements.

Keywords: fuel and energy resource, power factor, load factor, energy efficiency indicator, energy-saving technology, specific consumption of electric energy, air blower.

Introduction

The methodology of carrying out an energy inspection consists of analyzing the state of actually used energy supply systems, determining the structure and analyzing the dynamics of consumption of used energy resources in physical and value terms for energy resource use systems as a whole, determining the structure and analyzing the dynamics of consumption of each type of used energy resources in percentage terms and developing balances.

The article presents an energy analysis of an outdated model of an air blower, substantiating its irrelevance for modern industrial enterprises due to low energy efficiency, increased operating costs and the lack of modern technologies. Replacement with energy-efficient models can significantly reduce costs and increase productivity.

Main part

An air blower is one of the energy-intensive units at the facility. This unit is necessary to ensure technological processes, maintain operating conditions and improve energy efficiency of production. Modern units reduce the frequency of downtime, and reduced downtime means more stable production and less loss of profit. The nominal parameters of the 1111-3725/04 air blower with synchronous motors GYS 3/2 are given in Table 1. These parameters are important for analyzing the efficiency of the units and assessing their performance under operating conditions.

Table 1
Technical data of the 1111-3725/04 air blower

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Parameter name	Designation	Units of measurement	Value
Nominal (rated) capacity of synchronous electric motor	$P_{дв}$	kW	3000
Nominal (rated) efficiency coefficientof synchronous electric motor	$η_{дв}$	%	97
Rotation speed	f	rpm	3000
Power factor	cosf	-	0.86
Nominal (rated) voltage	U_H	V	6000
Nominal (rated) efficiency coefficientof air blower	$η_н$	%	73
Nominal (rated) volumetric performance of air blower	Q_H	m^3/sec	63
Nominal (rated) pressure of air blower	H	kgf/m^2	13750

Based on actual measurements taken at the installation site of the obsolete unit blower, the energy efficiency indicators of the air blower unit were calculated. These calculations allowed assessing the current efficiency of the power generating units and identifying possible areas for improving energy efficiency.

The obtained indicators include:

- Efficiency coefficient (EC) – an estimation of how much energy is converted directly into useful work.
- Specific energy consumption – an estimation of how much energy is consumed depending on the volume and pressure.

These indicators serve as a basis for analyzing and planning activities to optimize energy consumption at the enterprise.

Using the measured parameters, as well as the operating characteristics of the blower, we can determine its operating parameters: Q = 130000 m^3/h; H_{output} = 13550 kgf/m^2; t_{inpit} = 52^0 C; t_{output} = 52^0 C; $I_{изм}$ = 210 A; $η_{дв}$=0.968; cosφ=0.86;

Power on air blower shaft:

$$P_н = \sqrt{3} * I_{изм} * U_H * \cos f * η_{дв} = \sqrt{3} * 210 * 6000 * 0.86 * 0.968 = 1817 kW \quad (1)$$

Useful power of the air blower:

$$P_П = \frac{Q*H}{102*η_B} = \frac{130000*13550}{3600*0,73} = 670.3\ kW \quad (2)$$

Efficiency coefficientof the air blower:

$$η_H = \frac{P_П}{P_H} = \frac{670.3}{1817} = 0.367 \quad (3)$$

Efficiency coefficientof the air blower unit:

$$η_{H.a.} = η_{H.} * η_{дв} = 0,367 * 0,968 = 0,355 \quad (4)$$

Decrease of the coefficient of efficiency:

$$\Delta = \frac{\eta_{н.а.} - \eta_{н}}{\eta_{н}} * 100\% = \frac{0{,}355 - 0{,}73}{0{,}73} * 100\% = -51.4\% \qquad (5)$$

The measured and calculated data show that the 1111-3725/04 air blower with GYS 3/2 synchronous motors operates with a reduced efficiency from the nominal by 51.4%. According to the above data, the operation of the 1111-3725/04 air blower with GYS 3/2 synchronous motor at the enterprise is assessed as unsatisfactory. That is, the remaining 48.6% of energy is lost in the form of heat, friction, inefficient engine operation and mechanical losses. Old models of air blowers were not designed taking into account modern energy efficiency standards and require immediate replacement.

In order to estimate the efficiency of fuel and energy resources (FER) consumption of units, the energy efficiency indicators presented in Table 2 are used. These indicators allow assessing how rationally resources are spent during operation and identifying possible reserves for increasing energy efficiency.

The main energy efficiency indicators included in Table 2:

1. Efficiency coefficient (EC) – reflects the ratio of useful energy to the total energy expended, showing the efficiency of the unit.
2. Specific fuel consumption – the volume of fuel consumed per unit of work, which helps to assess fuel efficiency.

Table 2

Energy efficiency indicators

Indicator	**Unit of measurement**	**Designation**	**Characteristic**
Efficiency coefficient	-	η	Relative energy efficiency index
Specific electric energy consumption	kW·h/kW·h	$E_{эк}$	Specific energy efficiency index

The EC of the air blower in the operating and set mode was determined during the instrumental inspection and made up to 0.355 [5]

The difference in the EC values indicates variations in their performance characteristics and may indicate differences in the technical condition or operating conditions of the unit.

The actual specific energy consumption of the air blower $E_{эк}$ kWh/kWh is calculated using the formula:

$$E_{эк}^{ДВ\text{-}1} = \frac{1}{\eta_{ДВ-1}} = \frac{1}{0{,}49} = 2{,}041 \text{ kWh/kWh} \qquad (6)$$

The obtained data from the analysis of the energy efficiency indicators and the performance characteristics of the air blower are presented in Table 3.

Table 3

Comparative analysis of the energy efficiency indicators of the air blower

Indicator	**Nominal, standard values**	**Actual values**
EC of ДВ-1	0.73	0.49
Specific electric energy consumption of ДВ-1	1.37	2.041

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Conclusion

In order to reduce energy consumption at modern enterprises with this type of air blowers, it is necessary to install a modern high-efficiency motors. Regular inspection of the electric motor, mechanical units and other components of the pumping unit will help to promptly detect faults and wear that can reduce the energy efficiency of the unit. The use of continuous equipment condition monitoring systems (vibration diagnostics, thermographic control and others) will allow timely identification of potential problems that can lead to decreased efficiency or accidents, switching to low-resistance bearings.

The importance of professional training of operating personnel also should be noted, which will allow better control of the equipment operation and maintain it in the optimal operating mode. The implementation of an energy control system that includes continuous monitoring of energy consumption will effectively identify areas for optimization and carry out corrective actions for improving energy efficiency.

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